Pool Ridge Farms Well Pumping Test

2425 Pool Ridge Road, Guerneville
APN 069-160-027
UPC17-0013

Submitted to:

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Permit Sonoma
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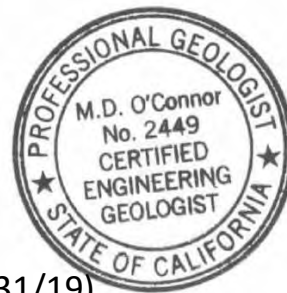
Prepared for:

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Prepared by:

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Contents

Introduction

In November 2017, EBA Engineering submitted a Groundwater Report to the County of Sonoma for a proposed cannabis cultivation project at 2425 Pool Ridge Road. In September 2018, Permit Sonoma Natural Resources Geologist Robert Pennington requested an additional 24-hour pump test of the project well prior to approval of the use permit.   Mr. Pennington's request was motivated by concerns regarding sustainability of access to groundwater based on (1) the dynamic pumping level previously observed in the project well was the same as the pump intake, and (2) the estimated aquifer storage volume is equivalent to that of the proposed annual project water use.   In addition to Permit Sonoma's concerns, neighbors on adjacent parcels were interested in developing information that could better-define the hydraulic connection between the wells near the project site.

This report summarizes the findings of a well pump test at the project site performed in October 2018. The results of this pump test analysis in conjunction with the previous findings from the groundwater study provides the basis for evaluating potential impacts of groundwater use for the proposed cannabis cultivation project. Potential impacts are evaluated with respect to potential well interference and other potential impacts on groundwater supply on neighboring parcels. Appendix A shows a summary of AQTESOLV calculations. Appendix B is a copy of the completed Certification of Water Yield in Water Scarce Areas form.

The local area geology, local groundwater conditions, and groundwater recharge processes are described in the prior EBA groundwater study (November 2017). In this report it is assumed that the reader is familiar with the local area geology as described in the prior report.

Pump Test Design and Monitoring Plan

Three wells were monitored before, during, and after the pump test: the project well on the project parcel, Well 2425, and two wells (Well 4 and Well 5) on adjacent parcels to the east and south located at 2480 and 2430 Pool Ridge Road (Figure 1 & Table 1). Wells 2425 and 4 are completed within the fractured bedrock aquifer associated with Franciscan sandstone (geologic map unit TKfs) to respective depths of 183 and 127 feet. Well 5, located to the south of the project well is located across an approximately located fault contact which separates the TKfs geologic unit from the KJfs geologic unit comprised of greywacke and mélange.   The well completion report obtained for Well 5 indicates a completed depth of 198 (Table 1).

Pressure transducers (Solonist Troll 700's) were deployed in Wells 2425, 4, and 5 to record water levels at one minute intervals over the three day period between October 23rd and October 25th, 2018. Manual water level measurements were taken periodically throughout this period using an electronic water level indicator to validate the data from pressure transducers.

Nearly 24 hours of pre-test data were collected to observe background conditions with respect to groundwater elevations. A "constant" rate 24-hr pump test with a pumping rate of 3 gallons per minute (gpm) for the first four hours and 2.56 gpm for the remainder was performed on Well 2425 beginning at 9:07 AM on October 24th. Observations from the previous pumping test at

8.5 gpm for 6 hours resulted in the drawdown to the pump intake and therefore the initial pumping rate of 3 gpm was chosen in attempt to avoid a similar drawdown. The estimated peak daily demand for the project was reported by EBA to be 4,391 gpd, pumping at a rate of 3 gpm would nearly meet the demand totaling to 4,320 gallons.

The pumping rate was adjusted to 2.56 in hopes of more rapidly attaining a steady water elevation in the pumping well. After the 24-hr pump test was completed, 24-hrs of well recovery data were collected. Well owners were advised several days prior to the test to fill storage tanks so that pumping during the monitoring period could be avoided. No pumping occurred at the monitoring wells during the three-day monitoring period.

Static Water Level Results

The water level data from Wells 2425 and 5 indicate a trend of increasing water table elevation over the 23-hour pre-test period (Figures 2, 3 & 5). The rates of increase vary between the two wells, 0.25 feet per day at Well 2425 and 10.7 ft feet per day for Well 5. With respect to Well 5, this likely represent recovery from pumping that occurred prior to the beginning of the monitoring period. The rate of change in Well 2425 is much lower and could possibly result from seasonal changes in groundwater observed in prior similar tests in the region, or could also represent recovery from prior pumping. It is our understanding that water use from Well 2425 in the weeks prior to the test was relatively low. A substantial rainfall event of about 2 inches occurred in early October, and it is possible that groundwater recharge from that event may have induced a subtle "recovery" signal in groundwater elevation.

Well 4 water level data recorded prior to the start of pumping shows a somewhat different trend. During the time leading up to the start of pumping the water level in Well 4 increased by 0.04 ft over 9.5 hours (about 0.11 ft/day), then dropped by 0.018 ft over the next 3 hours (a drawdown rate of 0.14 ft/day) before returning to an increasing rate (0.027 ft over 7 hours beginning an hour into the pumping). Well 4 is not the main water source for the parcel APN 069-160-021, and had not been pumped for quite some time prior to the start of monitoring. The explanation for the varied signal may be a combination of the initial October rainfall-recharge event, recovery from earlier pumping in the aquifer, and erratic behavior of flow in this fractured bedrock aquifer.

A north-south and a southwest to northeast oriented transects through the wells shows relative water surface information. Due to the distances and uncertainty of the nature of the subsurface geologic materials water surface profiles are not included (Figures 2 and 3). Pre-test water surface elevations in the monitoring wells generally follow the topography. The pre-test water elevation in Well 2425 of 764 ft is 163 ft above the pre-test water surface elevation of Well 4 and 185 ft below the pre-test water elevation of Well 5.
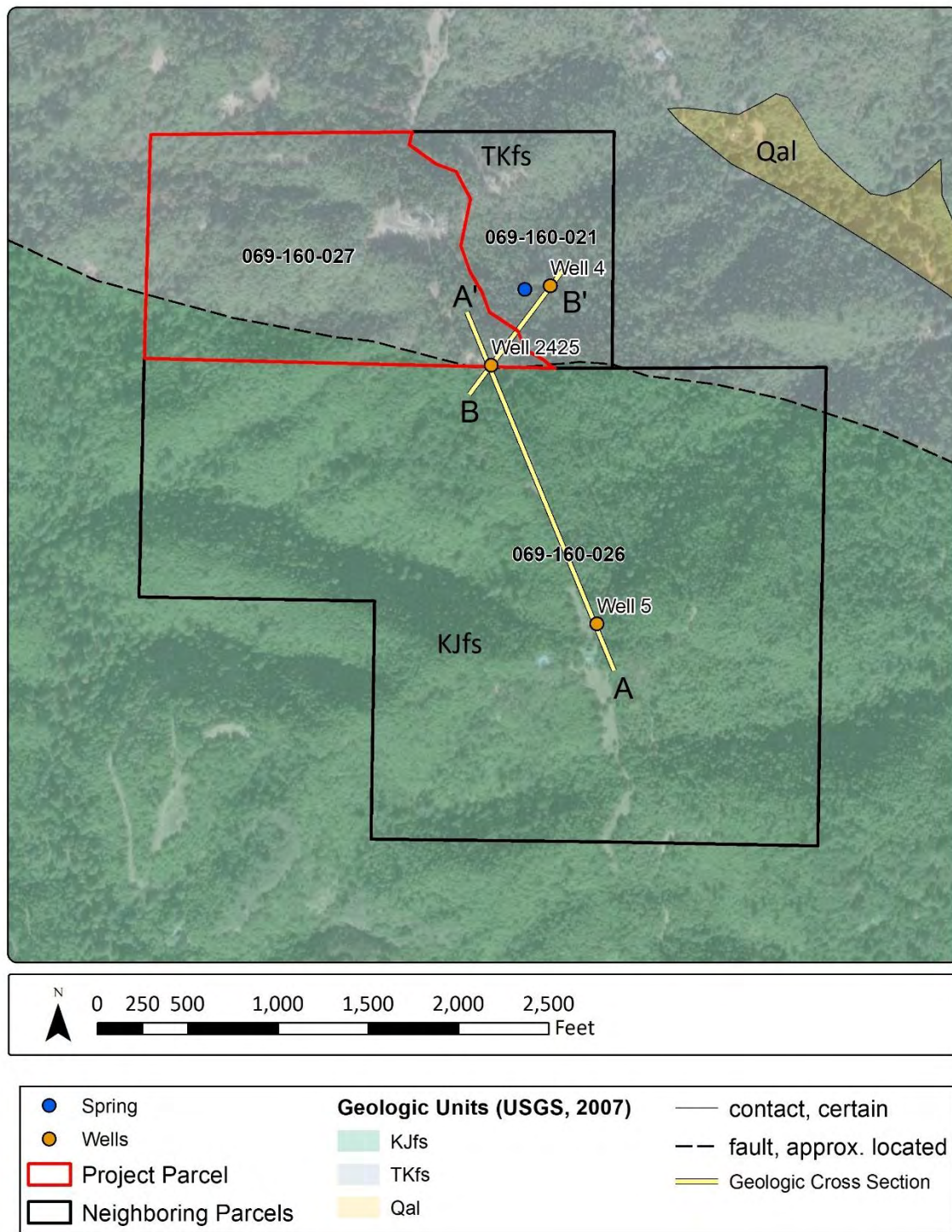
Figure 1: Well locations and surficial geology in the vicinity of the proposed Pool Ridge Farms cannabis operation.

Table 1: Well completion details for the seven wells included in the monitoring plan.

Well	APN	Year Completed	Depth (ft)	10/23/18 Depth to Water (ft)	Top of Screen (ft)	Bottom of Screen (ft)	Distance to Well 2425 (ft)	Map Unit
2425	069-160-027	1992	183	165.6	123	183	0	TKfs
4	069-160-021	1994	127	36.6	47	127	550	TKfs
5	069-160-026	2001	198	138.26	60	198	1547	KJfs
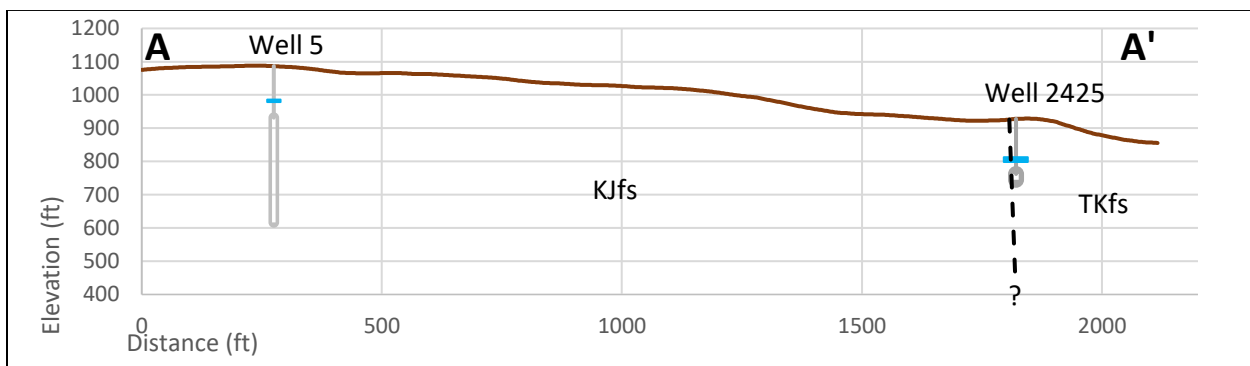
Figure 2: Transect of static groundwater elevations on 10/23/18 (black dashed line represents the fault contact separating the KJfs and TKfs. The transect is oriented with south to the left and north to the right.
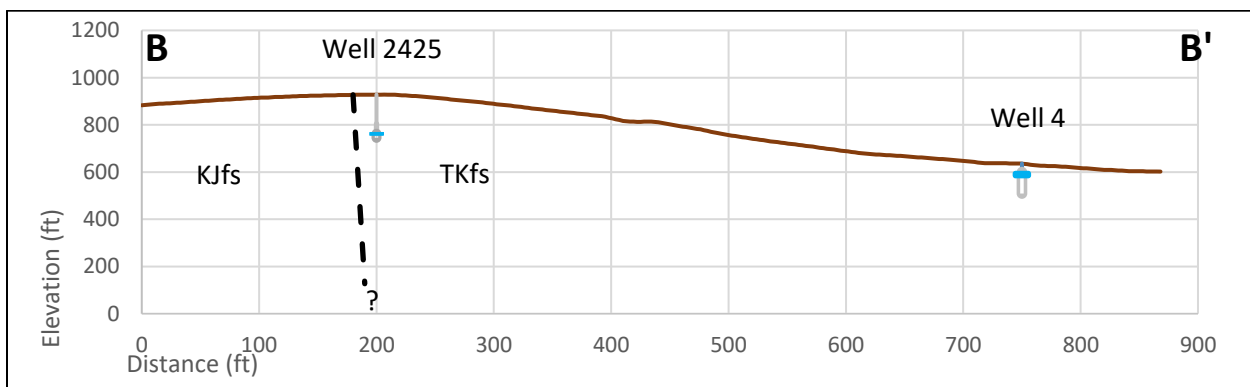
Figure 3: Transect of static groundwater elevations on 10/23/18 (black dashed line represents the fault contact separating the KJfs and TKfs. The transect is oriented with southwest to the left and northeast to the right.

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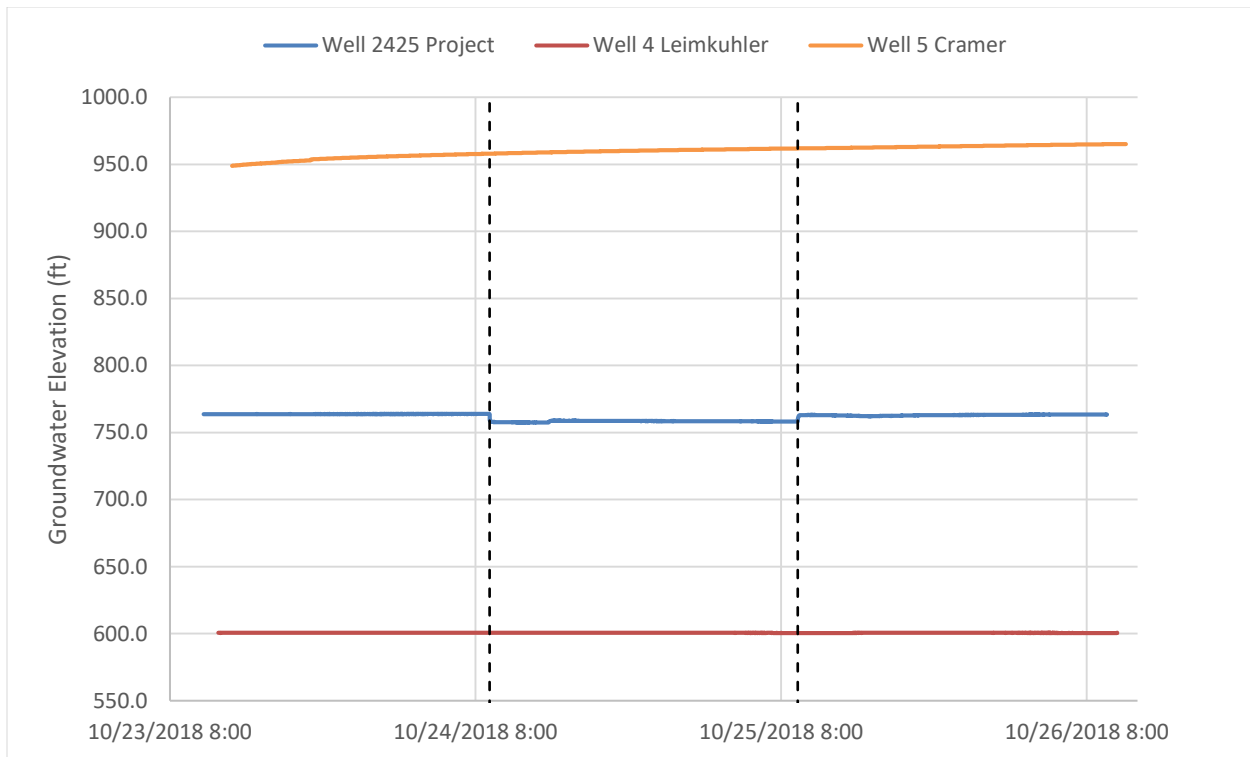
Figure 5: Groundwater elevation hydrographs at the three instrumented wells (2425, 4, & 5) during the 10/23/18 to 10/26/18 monitoring period. Dashed vertical lines indicate the pump test interval.
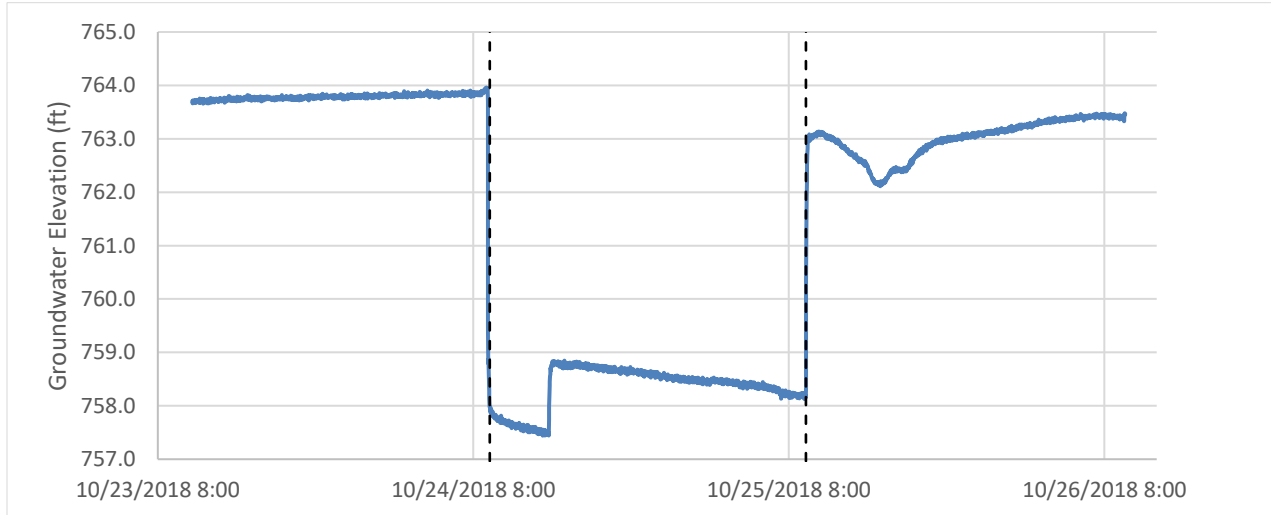
Figure 6: Groundwater elevation at Well 2425 during the 10/23/18 to 10/26/18 monitoring period. Note y-axis scale when comparing to hydrographs for neighboring wells.
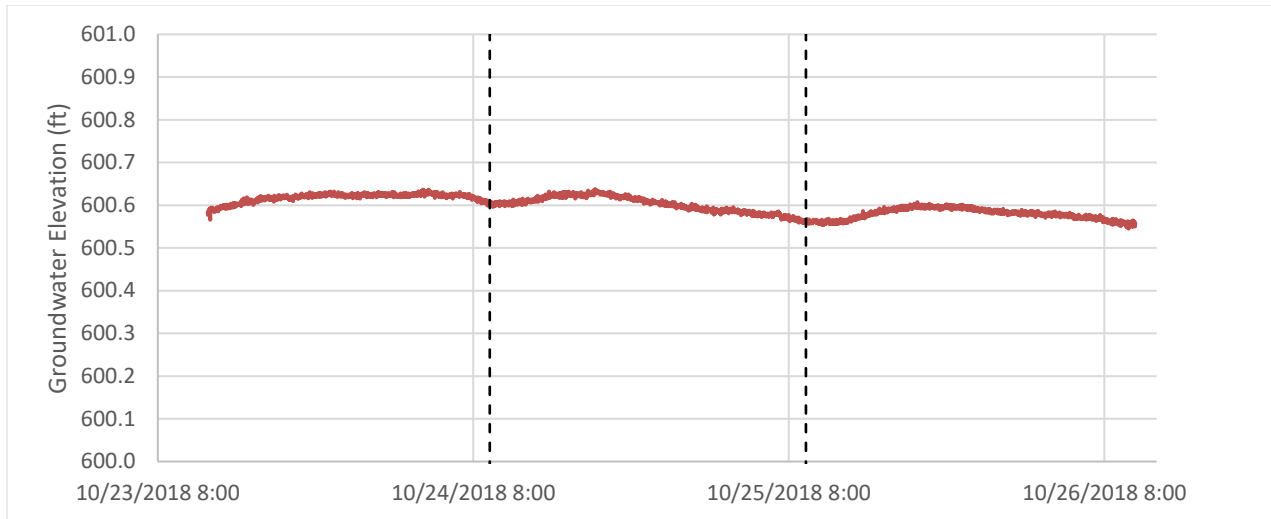
Figure 7: Groundwater elevation at Well 4 during the 10/23/18 to 10/26/18 monitoring period. Note y-axis scale when comparing to neighboring wells.

Figure 8: Groundwater elevation at Well 5 during the 10/23/18 to 10/26/18 monitoring period. Note y-axis scale when comparing to neighboring wells.

Pump Test Water Level Responses

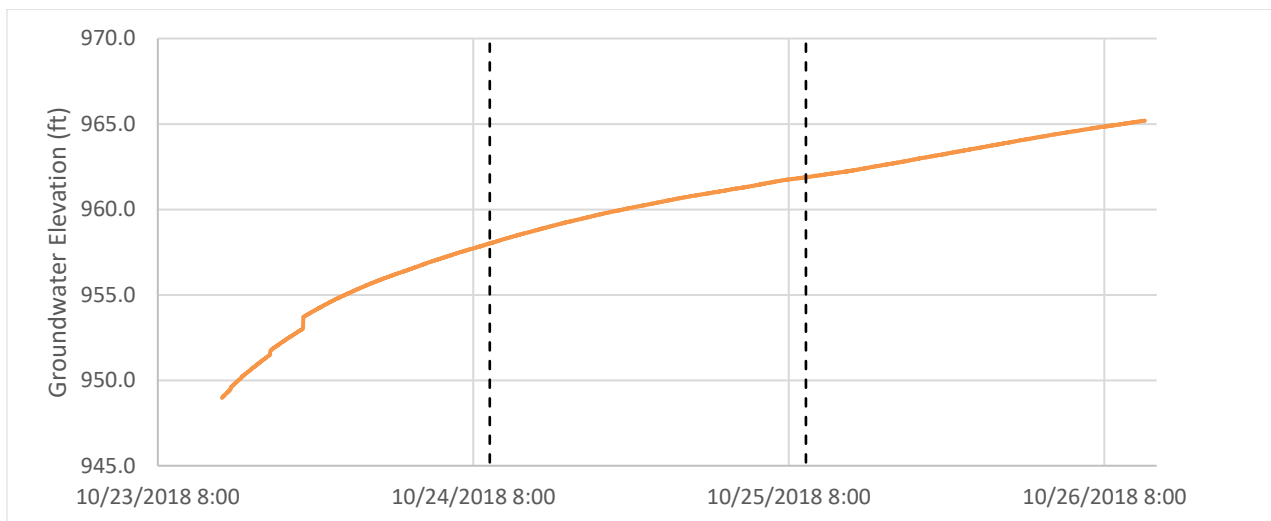Time-drawdown data at the pumping well (Well 2425) indicates that 4 hours of pumping at a rate of 3.00 gpm and then 2.56 gpm for 20 hours resulted in a maximum drawdown of 6.25 feet after the first four hours and a final drawdown of 5.6 ft at the end of pumping (Figures 5 and 6). Initially the water level dropped 5.7 ft in the first eight minutes (0.7 feet per minute), followed by a rapid decrease in drawdown for the next 270 minutes to a rate of 0.002 feet per minute. At 279 minutes into the test, the pumping rate was decreased to 2.56 gpm. This decrease in the pumping rate caused the water level to rise 1.3 ft over the next 12 minutes (0.11 ft per minute). At about 290 minutes into the test, drawdown resumes and remains constant at 0.0005 feet per minute until pumping ends at 1452 minutes into the test.

Immediately after the cessation of pumping the water level in Well 2425 recovers nearly 4.7 ft over 8 minutes (a rate of 0.58 ft per minute) and then begins to recover at a much lower rate of 0.007 ft per minute. About 50 minutes after pumping ended (1497 minutes since the onset of pumping) the water level declines 1 ft over 290 minutes, a rate of 0.0033 ft per minute. Recovery resumes at 1787 minutes since the onset of pumping initially at a rate of 0.003 ft per minute then decreases about 230 minutes later to 0.0006 ft per minute until the end of the measurement period 24 hours after the end of pumping.

The well recovers 75% of the maximum drawdown within the first minute, after which a 1 ft decline in the water surface is recorded for 290 minutes before recovery resumes for the remainder of the recovery period. It is uncertain why this decline in the water surface occurred since pumping had ceased almost 5 hours earlier. One possible explanation would be a reoccupation of a fracture that had been drained during pumping. After pumping ceased and as groundwater flow resumed from the most productive fractures (preferential flow paths) the well quickly recovered until pressure head within the well became great enough to force water into a fracture or fractures below the water level at that time. At the end of the 24-hour recovery period, the residual drawdown is 0.55 feet which represents 90.67% recovery of the pre-test elevation (Figure 5).

The time-drawdown data at the nearest monitoring well (Well 4, 550 ft to the north, Figure 1 and Figures 5 and 6) does not show a response to pumping. The water level in Well 4 does change very minimally throughout the active pumping period but the magnitude of these changes, on the order of hundredths of a foot is small enough that they cannot be separated from the signal recorded pre and post pumping. Water level in Well 4 was initially increasing by 0.027 ft for the first 7 hours of pumping a "recovery" rate of 0.00006 ft per minute followed by a decline in water elevation of 0.07 ft over the next 18 hours (a rate of 0.00007 ft per minute; Figure 4). These changes are very small--less than the pre-test signal in the pumping well where the water level was increasing at a rate of 0.0002 ft per minute--an order of magnitude greater than the rates observed in Well 4 during pumping hence it is concluded that no response to pumping occurred at Well 4.

The time/drawdown data at the other offsite monitoring well (Well 5 Located 1,547 ft to the south of the pumping well) does not show a response to pumping. Well 5 shows a recovery of over 16 ft over the three-day monitoring period (Figures 5 and 8). The rate of recovery slowly decreases throughout the three-day monitoring period; however, the change occurs gradually with no discontinuity associated with the onset or cessation of the pumping period (Figure 8).

Pump Test Analysis

The time-drawdown data for the pumping well (Well 2425) were analyzed using AQTESOLV software; a type curve matching approach was used to estimate aquifer properties. Usually the data from monitoring wells would be the focus on analysis in a test of this type, however because no response to pumping was observed, only the results from the pumping well were analyzed.

Interpretation of drawdown data from an observation well is considered more reliable than drawdown data from a pumping well since the pumping well response is often biased by the effects of wellbore storage and flow turbulence associated with interfaces between the filter pack and well screen. In particular, observation wells can be used to estimate the aquifer Storage Coefficient (S) as well as the aquifer Transmissivity (T), whereas pumping wells can only be used to estimate T. Furthermore, a response in the observation well would provide data characterizing aquifer hydraulics over the distance separating the pumping well and the observation well and would therefore be more representative of aquifer conditions.   Due to the lack of response to pumping in the observation well only the drawdown data from the pumping well were analyzed to provide estimates of the aquifier hydraulic properties.

The flow solution for a leaky confined aquifer (Hantush-Jacob, 1955) provided the best fit to the drawdown data. A leaky confined aquifer is described as a confined aquifer that loses or receives water from the surrounding formation (Driscoll,1986). The well log for Well 2425 describes a "shaley clay" layer above "blue shale" and "broken blue shale" layers atop "blue clay" located at the bottom of the borehole. This description is consistent with a confined or leaky confined fractured bedrock aquifer. The Hantush-Jacob solution was applied to the entire 24 hours of drawdown data from the pumping well (Well 2425) along with a subset of the drawdown data from the first 4 hours of pumping to provide estimates of T that describe flow in the aquifer; values for S are assumed. The 24-hour drawdown data includes drawdown responses to the two pumping rates (3 cfs and 2.56 cfs) while the drawdown data from the first 4 hours was associated with only the 3.0 gpm pumping rate. Fractured aquifer solutions ("Moench with slab blocks" and "Moench with spherical blocks", 1985) were also applied and they resulted in similar aquifer property estimates with a poorer fit, thus the leaky confined solutions were judged to be the most representative of the aquifer. This analysis thus estimated a range of T values of 38.6 to 105 ft^2/day (Table 2); S is assumed to be 1e^{-5}.

Recovery data from the pumping well (Well 2425) was also evaluated using AQTESOL. Fits were not stronger than those from analysis of the time-drawdown data. The confined aquifer (Theis), leaky confined aquifer (Hantush-Jacob) and fractured aquifer with slab blocks (Moench) solutions provided similar estimates of T (and higher than the time-drawdown estimates) ranging from about 525 ft^2/day to 963 ft^2/day (Table 2).

Analysis of pumping well data cannot directly provide an estimate of S; drawdown response data from an observation well would have allowed for direct estimation of S. A range of likely values of S are considered in an effort to estimate the radius of influence of the pumping well and the drawdown of water elevation that might be experienced in neighboring wells.
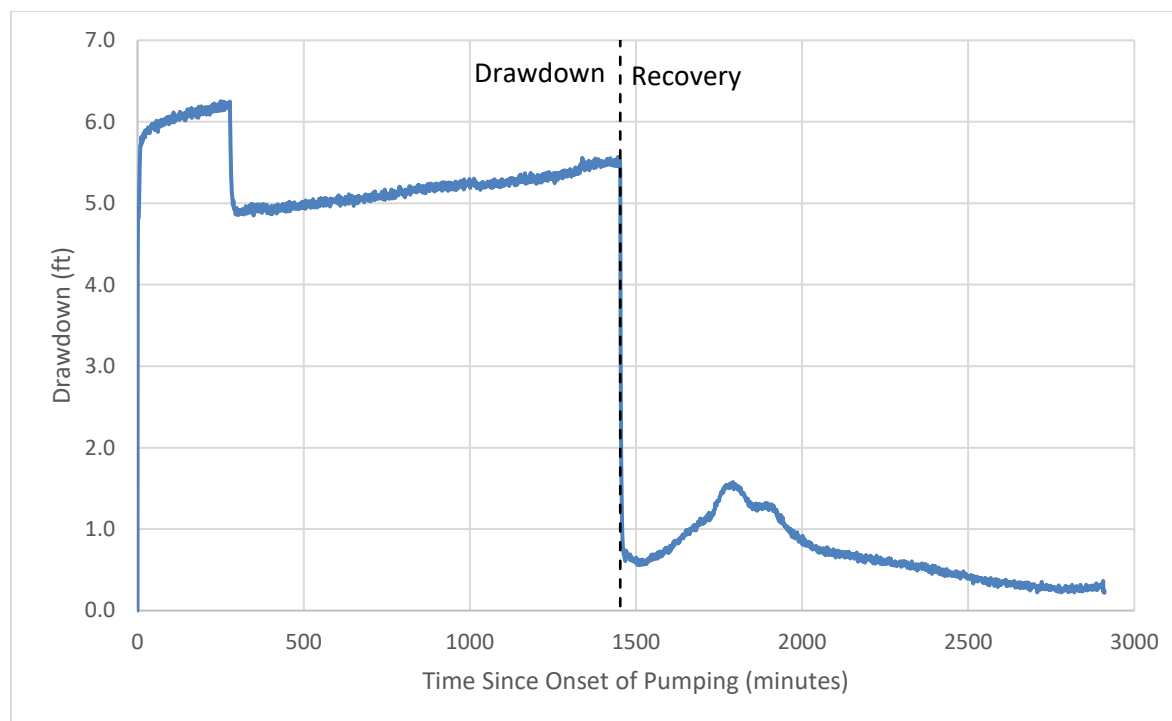
Figure 5: Time-drawdown data for the pumping well (Well 2425),.

Table 2: Results of the pump test analysis for well 2425.

Solution	Transmisivity (ft²/d)	Storage Coefficient	Notes
Leaky Confined- Hantush Jacob	38.6	1.00E-05	24 hrs drawdown
Leaky Confined- Hantush Jacob	104.7	5.60E-04	4 hrs drawdown at 3 gpm
Theis	524.8	-	Recovery
Leaky Confined- Hantush Jacob	660.1	-	Recovery
Moench w/ Slab Blocks	962.8	-	Recovery

Well Interference Analysis

Well interference is the term used to describe the effects of pumping a well on another well manifested by a depression of the water surface in an impacted well caused by the drawdown of a pumping well. Well interference effects are not necessarily significant if the extent of drawdown is small relative to the operational water levels in an impacted well. Generally, a few feet of drawdown caused by well interference would not be expected to significantly affect access to groundwater in an affected well.

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To better understand the character of the project aquifer and the lack of response to pumping observed at the neighboring observation wells (Wells 4 and 5), the range of hydraulic properties derived in AQTESOLV and from literature were used to estimate potential drawdown at various distances from the project well.

The Theis (1935) equation can be used to simulate the drawdown and cones of depression associated with the operation of the project well (Well 2425) that would be required to induce drawdown in the neighboring well:

 The Theis equation (from Bedient, Huber and Vieux, 2013) is as follows:

$$s' = (Q/4\pi T)\ W(u)$$

with W(u) being the well function where

$$u = (r^2 S/4Tt)$$

and the well function integral expanded as a series as:

$$W(u) = -0.5772 - \ln(u) + u - (u^2/2 \cdot 2!) + (u^3/3 \cdot 3!) - (u^4/4 \cdot 4!)\dots$$

where:

s' = drawdown (units in ft)

r = radial distance (units in ft)

S = storativity (dimensionless)

T = transmissivity (units in ft^2/day)

Q = discharge at the well (in gpm)

t = time (days)

The equation was solved using a range of estimates of T (38.6 to 105 ft^2/day or 288.7 to 785.3 gpd/ft) and S (1e^{-5} to 1e^{-3}) derived from the analysis of Wells 2425 with the upper end of the range of S values found in literature for confined aquifers (Lohman, 1972). Table 3 shows solutions from the various combinations of input parameters. Drawdowns calculated using the S values of 0.00001 and 0.0001 gave positive drawdown values with the two T values determined from the AQTESOLV analysis. Estimated drawdown ranges from about 1.6 to 5.4 ft at a well 550 ft from the pumping well. With an S value of 0.001 for a well 550 ft from the pumping well, only the upper estimate for T (785.3 gpd/ft) predicted drawdown of 0.022 ft.

The fact that no drawdown was observed in Well 4 and that some of the estimated aquifer properties estimate drawdowns at 550 ft from the pumping well indicates the some of the estimated aquifer hydraulic properties are not representative of the aquifer.

Table 3: Results of estimated drawdown calculations with range of hydraulic parameters. Note specific T values that resulted in near zero drawdown were solved for iteratively.

Q Pumping Rate (gpm)	T Transmissivity (gpd/ft)	t (days)	r Radius (ft)	S Storativity	s Drawdown (ft)
3	7.47	1	550	0.00001	0.0012
3	288	1	550	0.00001	4.26
3	785	1	550	0.00001	5.43
3	74.7	1	550	0.0001	0.00012
3	288	1	550	0.0001	1.58
3	785	1	550	0.0001	2.7
3	289	1	550	0.001	na
3	785	1	550	0.001	0.022
3	747	1	550	0.001	0.000012

The estimated drawdown of 0.022 ft associated with the T value of 785.3 gpd/ft and S of 0.001 is somewhat representative of drawdown observed in Well 4. However, since we have determined that the changes observed in Well 4 were not a response to pumping, we attempt to identify a potential range of T and S values that would produce near-zero drawdown at 550 ft. For each S value, T values were tested iteratively to find near-zero drawdown. Values that satisfy this condition range from 7.47 gpd/ft (1 ft^2/day) for S of 0.00001 to 747 gpd/ft (100 ft^2/day) for S of 0.001 (Table 3).   The combination of the highest T and S values estimate drawdown nearest to zero and suggest that these may be the best estimates of T and S for the aquifer from this test. .

For additional perspective, T values estimated from the analysis of the pumping well recovery data (Table 2) were used to estimate drawdown with a range of assumed S. Drawdown was estimated using the Theis equation applying an average T value from the recovery data of 715.9 ft^2/day (5,355.3 gpd/ft). Drawdown ranged from 0.12 ft (S = 0.001) to 0.41 ft (S = 0.0001).

Conclusions

A 24-hour duration pump test (3 gpm for the first 4 hours and 2.56 gpm for the remaining 20 hours) was conducted at Well 2425 on October 24th and 25th, 2018. The pumping resulted in 6.5-ft of drawdown at the pumping well after 4 hours; drawdown decreased with the reduction in pumping rate and finished at 5.8-ft after 24 hours. Water level in the well recovered rapidly

with 75% recovery within the first 50 minutes after the test. After 24 hours the well had recovered to 91.5% of the pre-test water surface elevation. Well 4, which is located 550-feet away from Well 2425, did not show a response to pumping.

The time/drawdown data from the pumping well were described using a variety of leaky confined solutions resulting in estimates of Transmisivity ranging from 38.6 to 105 ft^2/day (289 to 785 gpd/ft) and a default estimate of the Storage Coefficient of 1e^{-5}. Results of these calculations indicate drawdown would occur with the two smaller S values of 0.00001 and 0.0001 suggesting that these estimate were not plausible. The higher T and S estimates of 105 ft^2/day (785.3 gpd/ft) and 0.001 predicted drawdown close to the zero drawdown in water level observed in Well 4. Further investigation of T values more tightly constrain the possible T and S values (100 ft^2/day (747 gpd/ft) and 0.001) to achieve zero drawdown in a well 550 from the pumping well.

The results of this pumping test indicate that the proposed cannabis cultivation should not have any negative impacts to nearby wells including Well 4 and Well 5. County regulations will require quarterly monitoring of water elevation in the project well and metering to document actual water use. Excess pumping from the project well and significant changes in water level in the project well should trigger a reevaluation of the project and any other activities related to groundwater use in the area.

References

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Appendix A

AQTESOLV Analysis of project pumping well

Project Pumping Well

Evaluation of drawdown data only

Diagnostic Statistics

Estimation complete! Corrections satisfy convergence requirements, but lambda is still large. Check parameter correlations and try more iterations as required.

Aquifer Model: Confined
Solution Method: Theis

Estimated Parameters

Parameter	Estimate	Std. Error	Approx. C.I.	t-Ratio	
T	128.9	3.036	+/- 5.956	42.46	ft^2/day
S	1.0E-5	3.78E-6	+/- 7.417E-6	2.645	
Kz/Kr	1.	not estimated			
b	60.	not estimated			ft

C.I. is approximate 95% confidence interval for parameter
t-ratio = estimate/std. error
No estimation window

K = T/b = 2.148 ft/day (0.0007578 cm/sec)
Ss = S/b = 1.667E-7 1/ft

Parameter Correlations

	T	S
T	1.00	-1.00
S	-1.00	1.00

Residual Statistics

for weighted residuals

Sum of Squares .... 139.9 ft^2
Variance .... 0.09651 ft^2
Std. Deviation....... 0.3107 ft
Mean .... 0.0004314 ft
No. of Residuals 1452
No. of Estimates 2
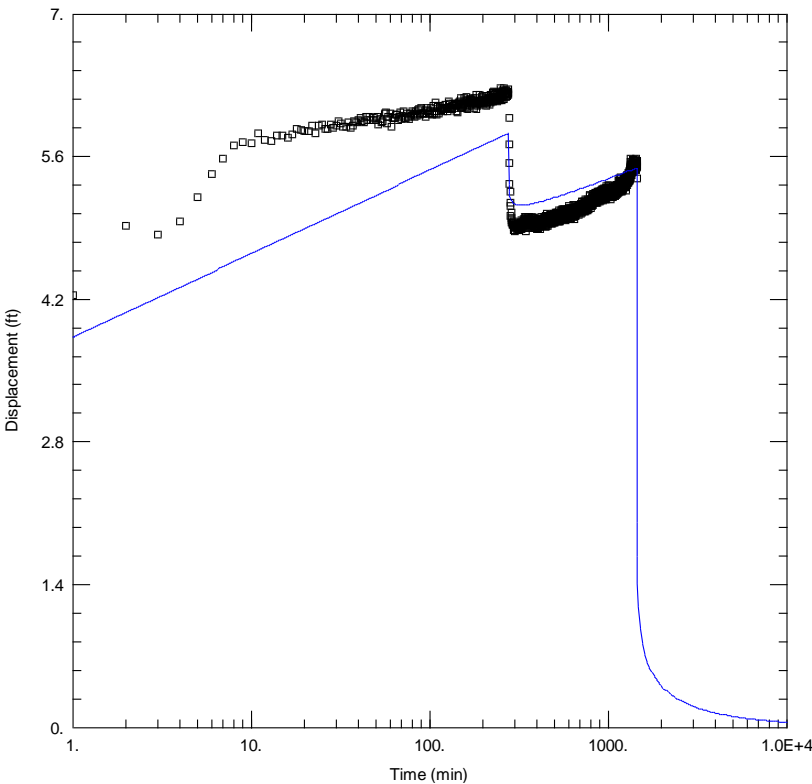
Obs. Wells
□ Well 1 DrawdownOnly

Aquifer Model
Confined

Solution
Theis

Parameters
T   = 128.9 ft^2/day
S   = 1.0E-5
Kz/Kr = 1.
b   = 60. ft

Aquifer Model: Confined
Solution Method: Cooper-Jacob

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Estimated Parameters

Parameter	Estimate	Std. Error	Approx. C.I.	t-Ratio	
T	128.9	2.97	+/- 5.827	43.4	ft^2/day
S	1.0E-5	3.698E-6	+/- 7.255E-6	2.705	

C.I. is approximate 95% confidence interval for parameter
t-ratio = estimate/std. error
No estimation window

K = T/b = 2.148 ft/day (0.0007579 cm/sec)
Ss = S/b = 1.667E-7 1/ft

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Parameter Correlations

	T	S
T	1.00	-1.00
S	-1.00	1.00

_____

Residual Statistics

for weighted residuals

Sum of Squares .... 129.9 ft^2
Variance .... 0.08968 ft^2
Std. Deviation....... 0.2995 ft
Mean .... -0.0009637 ft
No. of Residuals 1451
No. of Estimates 2
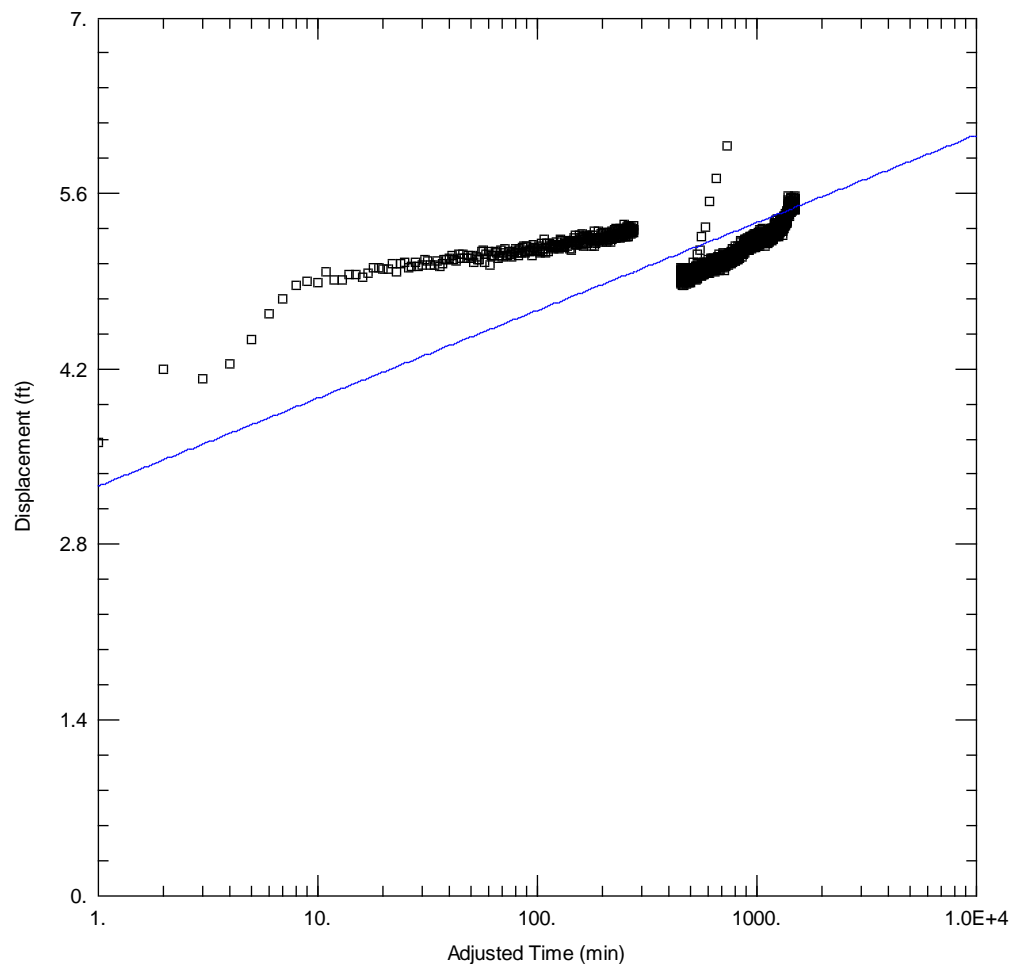
Obs. Wells
  □ Well 1 DrawdownOnly

Aquifer Model
  Confined

Solution
  Cooper-Jacob

Parameters
  T = 128.9 ft^2/day
  S = 1.0E-5

Diagnostic Statistics

Estimation complete! Corrections satisfy convergence requirements, but lambda is still large. Check parameter correlations and try more iterations as required.

Aquifer Model: Unconfined
Solution Method: Theis

Estimated Parameters

Parameter	Estimate	Std. Error	Approx. C.I.	t-Ratio	
T	135.3	3.039	+/- 5.963	44.52	ft^2/day
S	1.0E-5	3.617E-6	+/- 7.096E-6	2.765	
Kz/Kr	1.	not estimated			
b	60.	not estimated			ft

C.I. is approximate 95% confidence interval for parameter
t-ratio = estimate/std. error
No estimation window

K = T/b = 2.255 ft/day (0.0007955 cm/sec)
Ss = S/b = 1.667E-7 1/ft

Parameter Correlations

	T	S
T	1.00	-1.00
S	-1.00	1.00

Residual Statistics

for weighted residuals

Sum of Squares . . . . 137.7 ft^2
Variance . . . . 0.09496 ft^2
Std. Deviation. . . . . . . 0.3082 ft
Mean . . . . 0.000537 ft
No. of Residuals 1452
No. of Estimates 2

Diagnostic Statistics

Estimation complete! Corrections satisfy convergence requirements, but lambda is still large. Check parameter correlations and try more iterations as required.

Aquifer Model: Unconfined
Solution Method: Cooper-Jacob

Estimated Parameters

Parameter	Estimate	Std. Error	Approx. C.I.	t-Ratio	
T	135.3	2.962	+/- 5.812	45.68	ft^2/day
S	1.0E-5	3.524E-6	+/- 6.915E-6	2.837	

C.I. is approximate 95% confidence interval for parameter
t-ratio = estimate/std. error
No estimation window

K = T/b = 2.255 ft/day (0.0007956 cm/sec)
Ss = S/b = 1.667E-7 1/ft

Parameter Correlations

|	T	S
T	1.00	-1.00
S	-1.00	1.00

Residual Statistics

for weighted residuals

Sum of Squares .... 127.3 ft^2
Variance .... 0.08783 ft^2
Std. Deviation....... 0.2964 ft
Mean .... -0.0009122 ft
No. of Residuals 1451
No. of Estimates 2
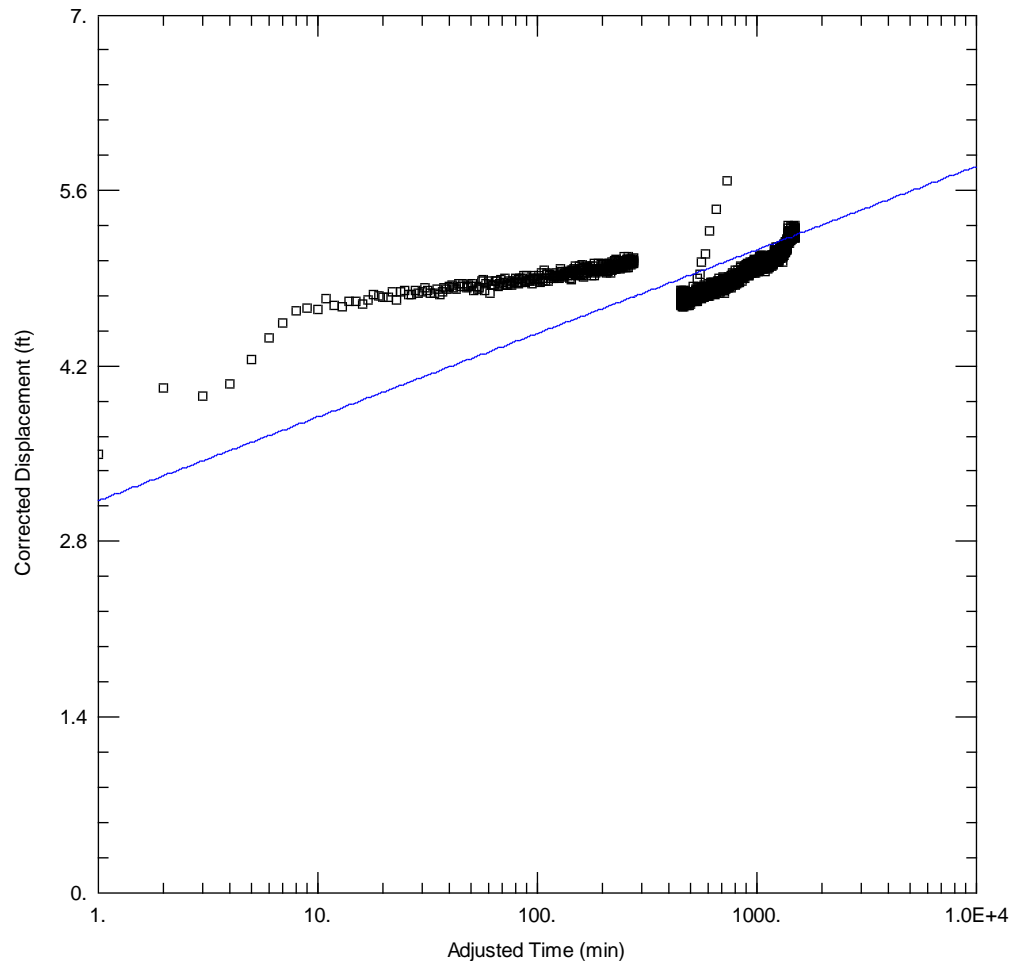
Obs. Wells
□ Well 1 DrawdownOnly

Aquifer Model
Unconfined

Solution
Cooper-Jacob

Parameters
T = 135.3 ft^2/day
S = 1.0E-5

Diagnostic Statistics

Estimation complete! No further improvement possible.

Aquifer Model: Leaky
Solution Method: Hantush-Jacob
_____

Estimated Parameters

Parameter	Estimate	Std. Error	Approx. C.I.	t-Ratio	
T	38.57	2.842E+5	+/- 5.575E+5	0.0001358	ft^2/day
S	1.0E-5	0.2317	+/- 0.4547	4.315E-5	
r/B	0.08852	1672.9	+/- 3282.3	5.291E-5	
Kz/Kr	1.	not estimated			
b	60.	not estimated			ft

C.I. is approximate 95% confidence interval for parameter
t-ratio = estimate/std. error
No estimation window

K = T/b = 0.6429 ft/day (0.0002268 cm/sec)
Ss = S/b = 1.667E-7 1/ft
K'/b' = 0.0004722 min^{-1}
K' = 0.6799 ft/day
_____

Parameter Correlations

	T	S	r/B
T	1.00	0.00	-1.00
S	0.00	1.00	0.00
r/B	-1.00	0.00	1.00
_____

Residual Statistics

for weighted residuals

Sum of Squares .... 77.82 ft^2
Variance .... 0.0537 ft^2
Std. Deviation....... 0.2317 ft
Mean .... 0.004397 ft
No. of Residuals 1452
No. of Estimates 3
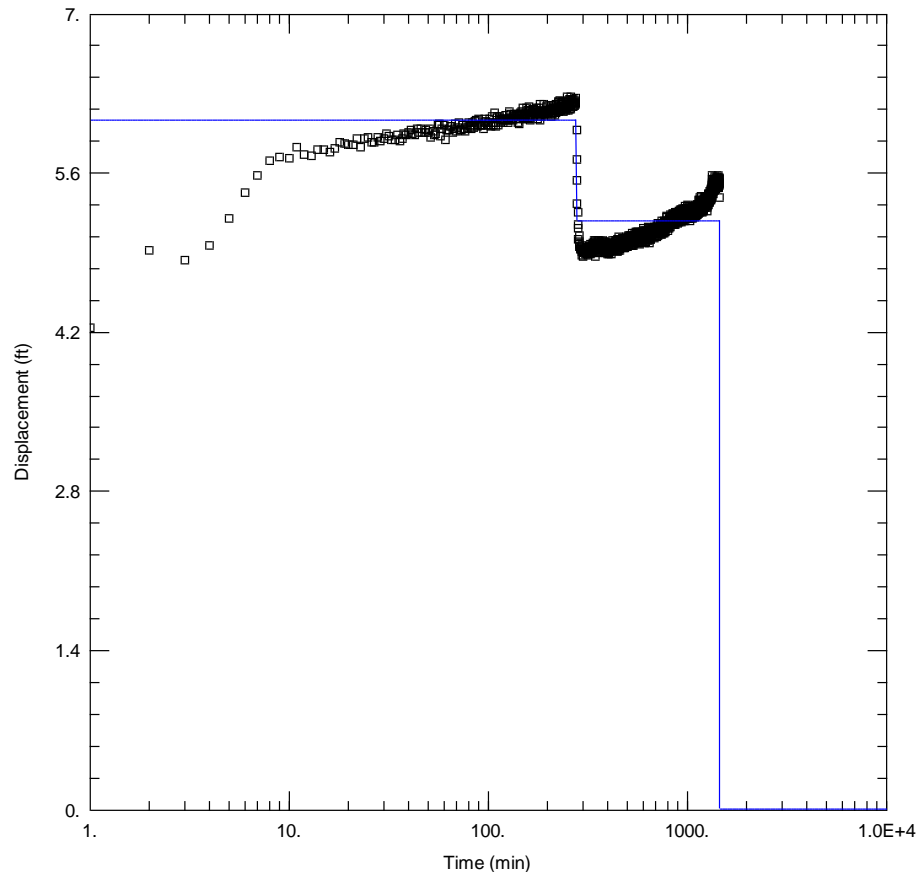
Obs. Wells
   □ Well 1 DrawdownOnly

Aquifer Model
   Leaky

Solution
   Hantush-Jacob

Parameters
   T   = 38.57 ft^2/day
   S   = 1.0E-5
   r/B = 0.08852
   Kz/Kr = 1.
   b   = 60. ft

Diagnostic Statistics

Estimation complete! Corrections satisfy convergence requirements, but lambda is still large. Check parameter correlations and try more iterations as required.

Aquifer Model: Fractured
Solution Method: Moench w/slab blocks

Estimated Parameters

Parameter	Estimate	Std. Error	Approx. C.I.	t-Ratio	
K	1.195	0.09432	+/- 0.1851	12.67	ft/day
Ss	1.667E-7	7.071E-6	+/- 1.387E-5	0.02357	ft^{-1}
K'	2.306E-5	5.871E-5	+/- 0.0001152	0.3928	ft/day
Ss'	0.000479	0.0015	+/- 0.002943	0.3193	ft^{-1}
Sw	0.	not estimated			
Sf	0.	not estimated			
r(w)	0.6667	not estimated			ft
r(c)	0.4167	not estimated			ft

C.I. is approximate 95% confidence interval for parameter
t-ratio = estimate/std. error
No estimation window

K = 0.0004216 cm/sec
T = K*b = 71.71 ft²/day (0.7711 sq. cm/sec)

Parameter Correlations

	K	Ss	K'	Ss'
K	1.00	0.86	0.21	-0.62
Ss	0.86	1.00	0.07	-0.45
K'	0.21	0.07	1.00	-0.90
Ss'	-0.62	-0.45	-0.90	1.00

Residual Statistics

for weighted residuals

Sum of Squares . . . . 221.2 ft^2
Variance . . . . 0.1528 ft^2
Std. Deviation. . . . . . . 0.3908 ft
Mean . . . . 0.01767 ft
No. of Residuals 1452
No. of Estimates 4
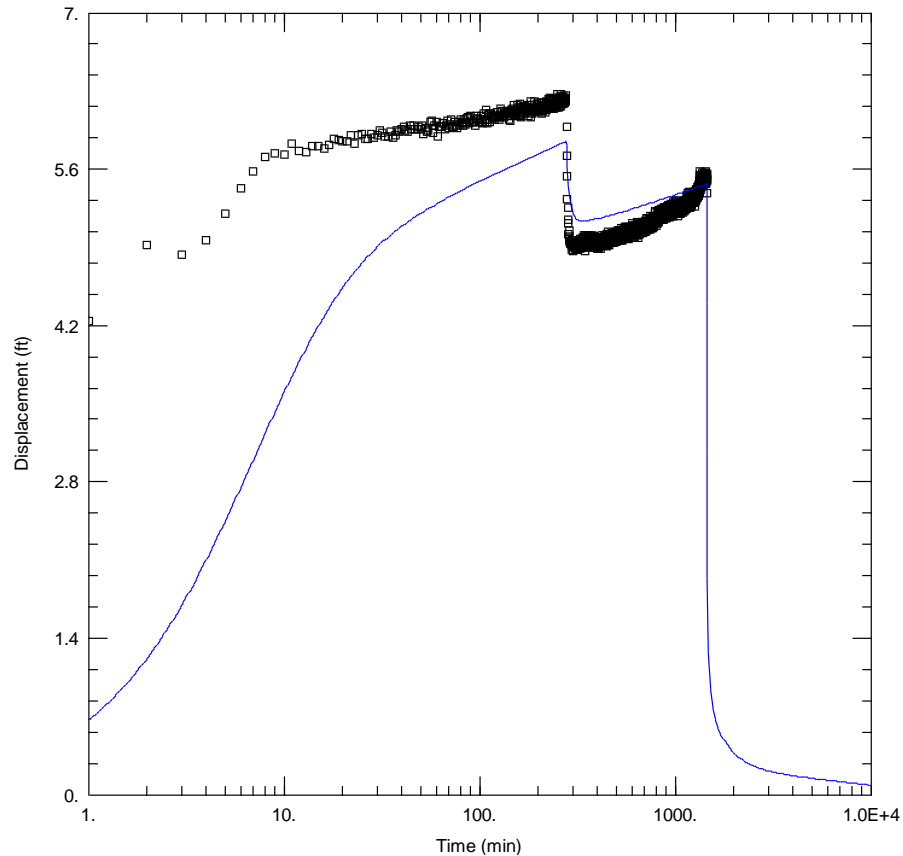
Obs. Wells
  □ Well 1 DrawdownOnly

Aquifer Model
  Fractured

Solution
  Moench w/slab blocks

Parameters
  K   = 1.195 ft/day
  Ss   = 1.667E-7 ft^{-1}
  K'   = 2.306E-5 ft/day
  Ss' = 0.000479 ft^{-1}
  Sw = 0.
  Sf   = 0.
  r(w) = 0.6667 ft
  r(c) = 0.4167 ft

Diagnostic Statistics

Estimation complete! Parameter change criterion (ETOL) reached.

Aquifer Model: Fractured
Solution Method: Moench w/spherical blocks

Estimated Parameters

Parameter	Estimate	Std. Error	Approx. C.I.	t-Ratio	
K	2.176	+/- 0.1669	+/- 0.1669	25.59	ft/day
Ss	1.667E-7	0.0004555	+/- 0.0008936	0.0003659	ft^{-1}
K'	1.44E-7	1.451	+/- 2.847	9.924E-8	ft/day
Ss'	1.0E-10	0.0004532	+/- 0.0008893	2.206E-7	ft^{-1}
Sw	0.	not estimated			
Sf	0.	not estimated			
r(w)	0.6667	not estimated			ft
r(c)	0.4167	not estimated			ft

C.I. is approximate 95% confidence interval for parameter
t-ratio = estimate/std. error
No estimation window

K = 0.0007678 cm/sec
T = K*b = 130.6 ft²/day (1.404 sq. cm/sec)

Parameter Correlations

	K	Ss	K'	Ss'
K	1.00	0.31	-0.29	-0.31
Ss	0.31	1.00	-1.00	-1.00
K'	-0.29	-1.00	1.00	1.00
Ss'	-0.31	-1.00	1.00	1.00

Residual Statistics

for weighted residuals

Sum of Squares . . . . 258.3 ft^2
Variance . . . . 0.1784 ft^2
Std. Deviation. . . . . . . 0.4223 ft
Mean . . . . 0.09553 ft
No. of Residuals 1452
No. of Estimates 4
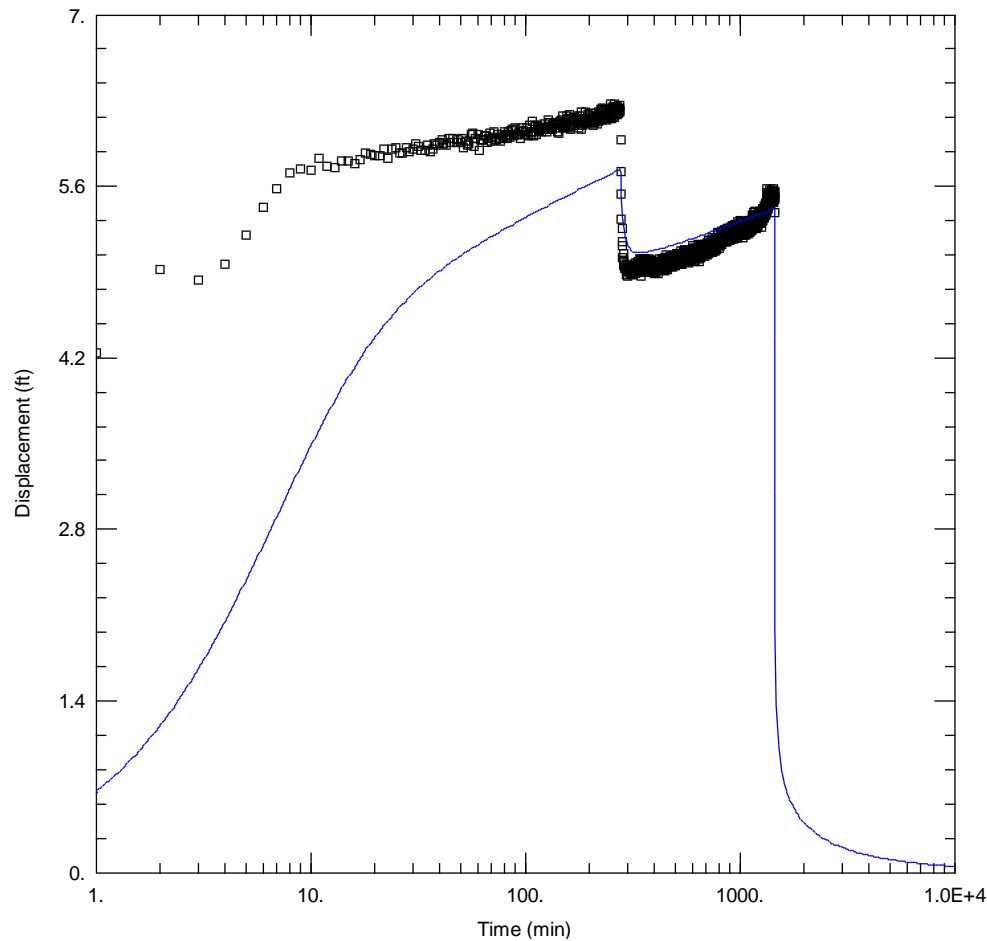
Obs. Wells
  □ Well 1 DrawdownOnly

Aquifer Model
  Fractured

Solution
  Moench w/spherical blocks

Parameters
  K   = 2.176 ft/day
  Ss   = 1.667E-7 ft^{-1}
  K'   = 1.44E-7 ft/day
  Ss' = 1.0E-10 ft^{-1}
  Sw   = 0.
  Sf   = 0.
  r(w) = 0.6667 ft
  r(c) = 0.4167 ft

Diagnostic Statistics

Estimation complete! Corrections satisfy convergence requirements, but lambda is still large. Check parameter correlations and try more iterations as required.

Aquifer Model: Fractured
Solution Method: Gringarten-Witherspoon w/vertical fracture

Estimated Parameters

Parameter	Estimate	Std. Error	Approx. C.I.	t-Ratio	
Kx	2.701	386.9	+/- 759.1	0.00698	ft/day
Ss	1.667E-7	2.383E-5	+/- 4.675E-5	0.006995	ft^{-1}
Ky/Kx	0.8581	245.9	+/- 482.4	0.00349	
Lf	1.	78.27	+/- 153.6	0.01278	ft

C.I. is approximate 95% confidence interval for parameter
t-ratio = estimate/std. error
No estimation window

K = 0.0009528 cm/sec
T = K*b = 162. ft²/day (1.742 sq. cm/sec)

Parameter Correlations

	Kx	Ss	Ky/Kx	Lf
Kx	1.00	0.40	-1.00	0.55
Ss	0.40	1.00	-0.40	-0.54
Ky/Kx	-1.00	-0.40	1.00	-0.55
Lf	0.55	-0.54	-0.55	1.00

Residual Statistics

for weighted residuals

Sum of Squares .... 110. ft^2
Variance .... 0.07595 ft^2
Std. Deviation....... 0.2756 ft
Mean .... 0.000521 ft
No. of Residuals 1452
No. of Estimates 4
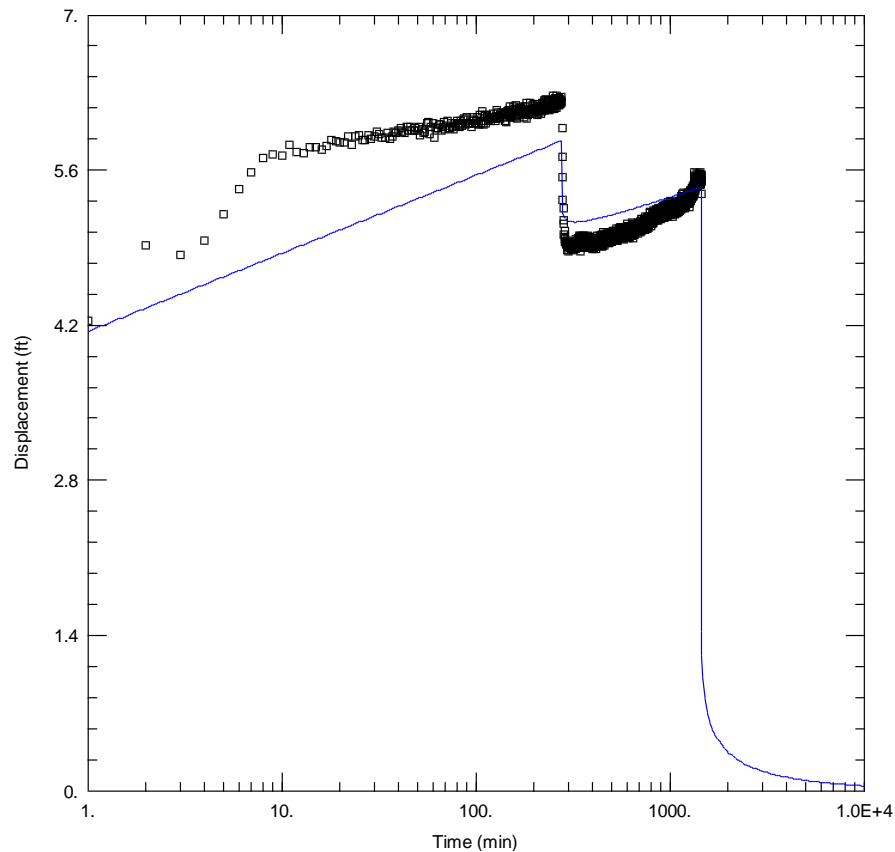
Obs. Wells
□ Well 1 DrawdownOnly

Aquifer Model
Fractured

Solution
Gringarten-Witherspoon w/vertical fracture

Parameters
Kx = 2.701 ft/day
Ss = 1.667E-7 ft^{-1}
Ky/Kx = 0.8581
Lf = 1. ft

Project Pumping Well

Initial Drawdown only from 4 hours of 3gpm pumping

Aquifer Model: Confined
Solution Method: Theis

Estimated Parameters

Parameter	Estimate	Std. Error	Approx. C.I.	t-Ratio	
T	116.2	3.915	+/- 7.708	29.67	ft^2/day
S	1.0E-5	4.828E-6	+/- 9.506E-6	2.071	
Kz/Kr	1.	not estimated			
b	60.	not estimated			ft

C.I. is approximate 95% confidence interval for parameter
t-ratio = estimate/std. error
No estimation window

K = T/b = 1.936 ft/day (0.000683 cm/sec)
Ss = S/b = 1.667E-7 1/ft

Parameter Correlations

	T	S
T	1.00	-1.00
S	-1.00	1.00

Residual Statistics

for weighted residuals

Sum of Squares .... 12.62 ft^2
Variance .... 0.04573 ft^2
Std. Deviation....... 0.2139 ft
Mean .... 0.0131 ft
No. of Residuals 278
No. of Estimates 2

Obs. Wells
□ Well 1 DrawdownOnly3gpm

Aquifer Model
Confined

Solution
Theis

Parameters
T   = 116.2 ft^2/day
S   = 1.0E-5
Kz/Kr = 1.
b   = 60. ft

Diagnostic Statistics

Estimation complete! Parameter change criterion (ETOL) reached.

Aquifer Model: Confined
Solution Method: Cooper-Jacob
_____

Estimated Parameters

Parameter	Estimate	Std. Error	Approx. C.I.	t-Ratio	
T	116.2	3.96	+/- 7.797	29.35	ft^2/day
S	1.0E-5	4.846E-6	+/- 9.541E-6	2.064	

C.I. is approximate 95% confidence interval for parameter
t-ratio = estimate/std. error
No estimation window

K = T/b = 1.937 ft/day (0.0006834 cm/sec)
Ss = S/b = 1.667E-7 1/ft
_____

Parameter Correlations

	T	S
T	1.00	-1.00
S	-1.00	1.00
_____

Residual Statistics

for weighted residuals

Sum of Squares .... 12.63 ft^2
Variance .... 0.04575 ft^2
Std. Deviation...... 0.2139 ft
Mean .... 0.01674 ft
No. of Residuals 278
No. of Estimates 2
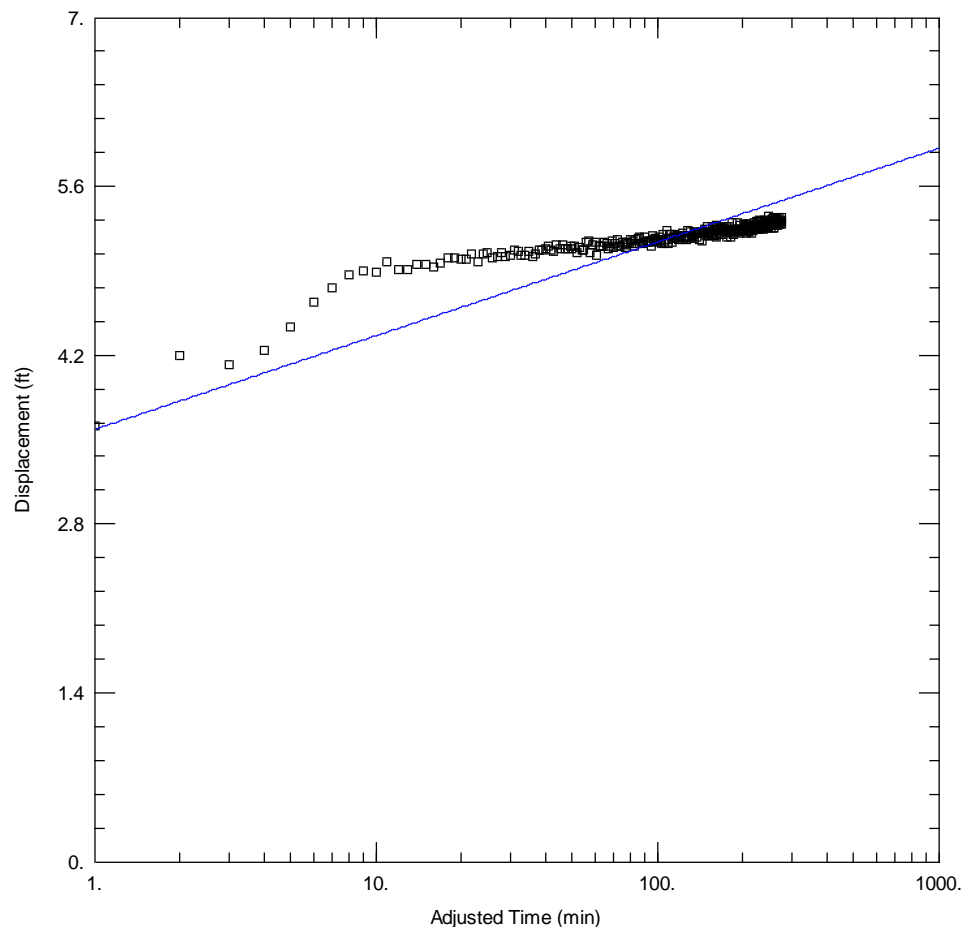
Obs. Wells
□ Well 1 DrawdownOnly3gpm

Aquifer Model
Confined

Solution
Cooper-Jacob

Parameters
T = 116.2 ft^2/day
S = 1.0E-5

Diagnostic Statistics

Estimation complete! Corrections satisfy convergence requirements, but lambda is still large. Check parameter correlations and try more iterations as required.

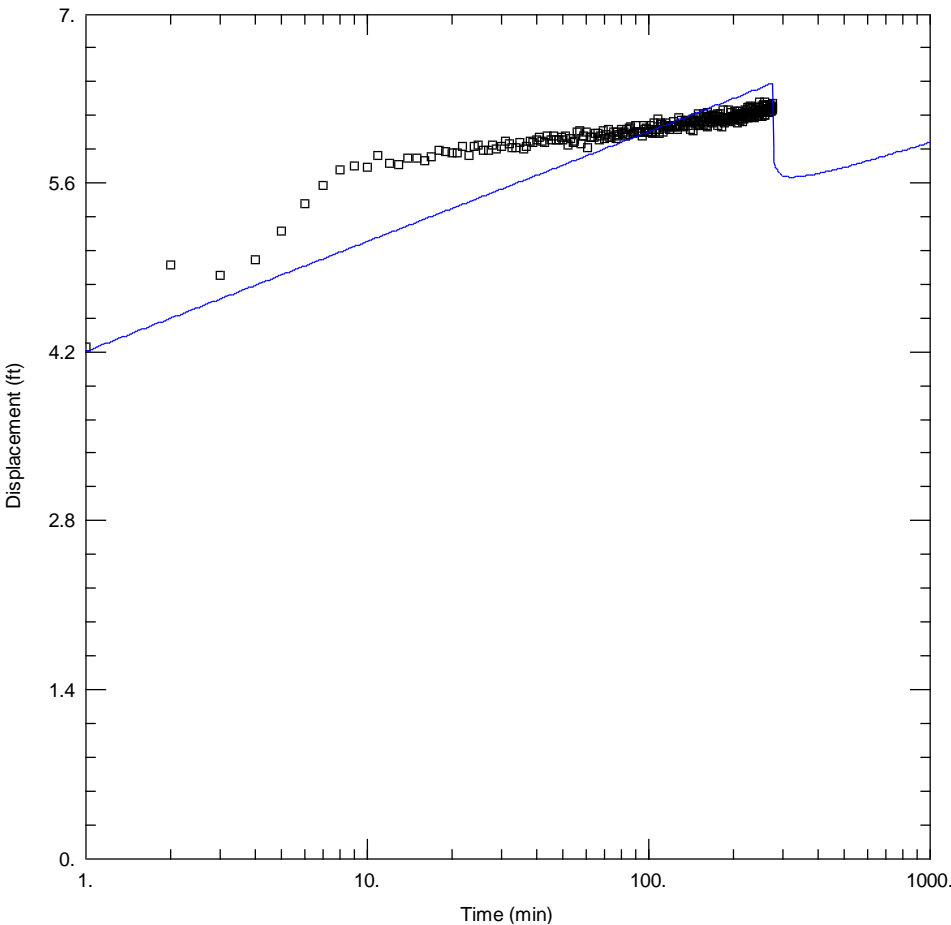Aquifer Model: Unconfined
Solution Method: Theis

Estimated Parameters

Parameter	Estimate	Std. Error	Approx. C.I.	t-Ratio	
T	122.8	4.292	+/- 8.451	28.62	ft^2/day
S	1.0E-5	5.03E-6	+/- 9.903E-6	1.988	
Kz/Kr	1.	not estimated			
b	60.	not estimated			ft

C.I. is approximate 95% confidence interval for parameter
t-ratio = estimate/std. error
No estimation window

K = T/b = 2.047 ft/day (0.0007223 cm/sec)
Ss = S/b = 1.667E-7 1/ft

Parameter Correlations

	T	S
T	1.00	-1.00
S	-1.00	1.00

Residual Statistics

for weighted residuals

Sum of Squares .... 14.63 ft^2
Variance .... 0.05301 ft^2
Std. Deviation....... 0.2302 ft
Mean .... 0.01585 ft
No. of Residuals 278
No. of Estimates 2
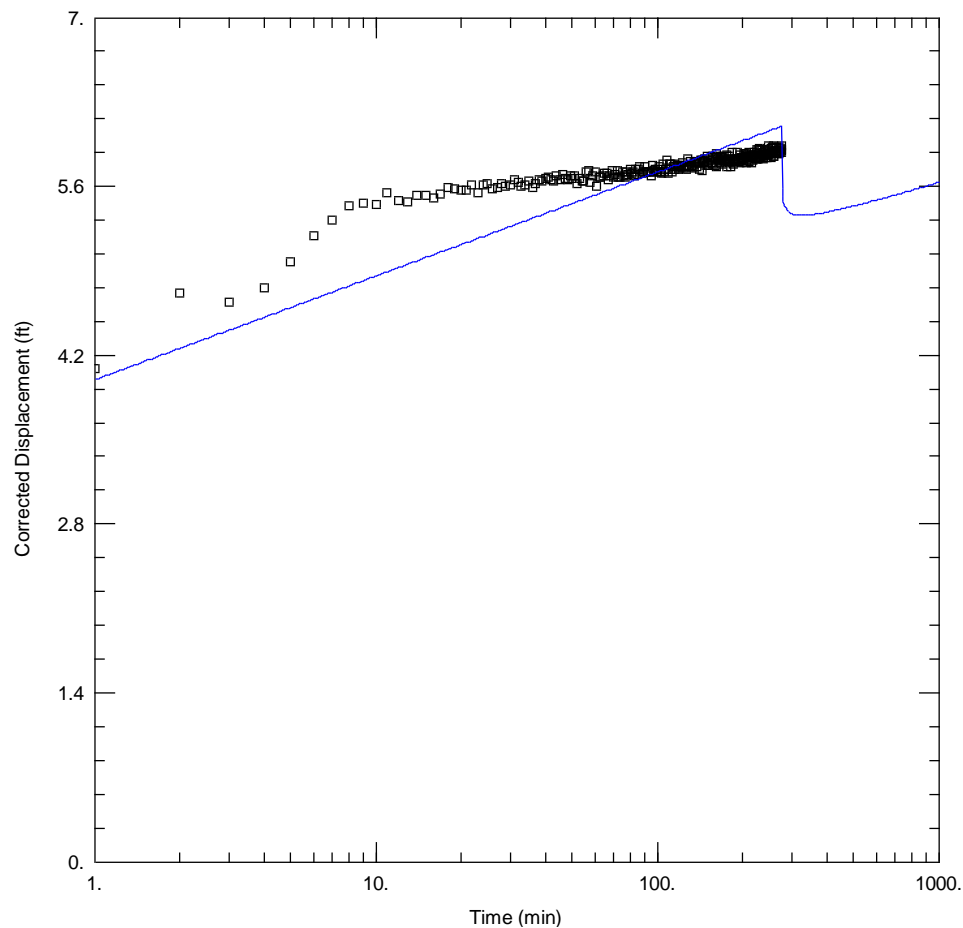
Obs. Wells
  □ Well 1 DrawdownOnly3gpm

Aquifer Model
  Unconfined

Solution
  Theis

Parameters
  T   = 122.8 ft^2/day
  S   = 1.0E-5
  Kz/Kr = 1.
  b   = 60. ft

Diagnostic Statistics

Estimation complete! Corrections satisfy convergence requirements, but lambda is still large. Check parameter correlations and try more iterations as required.

Aquifer Model: Unconfined
Solution Method: Cooper-Jacob

Estimated Parameters

Parameter	Estimate	Std. Error	Approx. C.I.	t-Ratio	
T	122.8	4.292	+/- 8.451	28.62	ft^2/day
S	1.0E-5	5.029E-6	+/- 9.903E-6	1.988	

C.I. is approximate 95% confidence interval for parameter
t-ratio = estimate/std. error
No estimation window

K = T/b = 2.047 ft/day (0.0007223 cm/sec)
Ss = S/b = 1.667E-7 1/ft

Parameter Correlations

	T	S
T	1.00	-1.00
S	-1.00	1.00

Residual Statistics

for weighted residuals

Sum of Squares . . . . 14.63 ft^2
Variance . . . . 0.05302 ft^2
Std. Deviation. . . . . . . 0.2302 ft
Mean . . . . 0.01585 ft
No. of Residuals 278
No. of Estimates 2
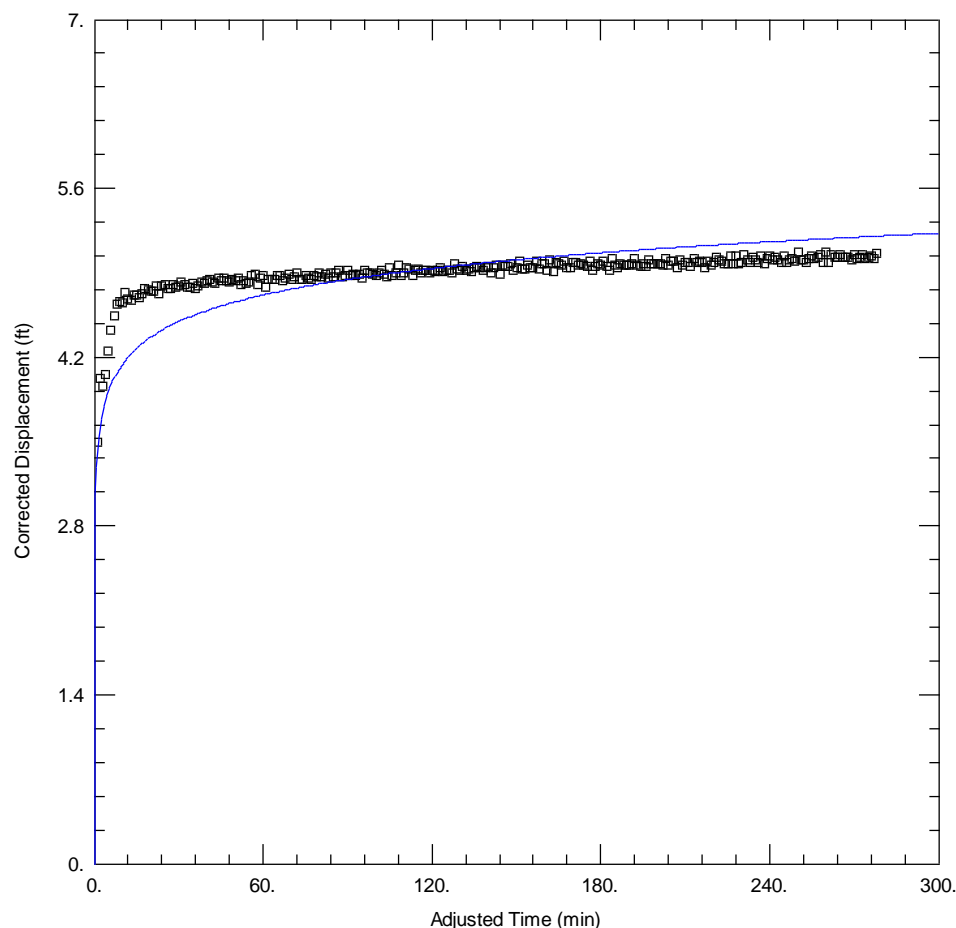
Obs. Wells
  □ Well 1 DrawdownOnly3gpm

Aquifer Model
  Unconfined

Solution
  Cooper-Jacob

Parameters
  T = 122.8 ft^2/day
  S = 1.0E-5

Diagnostic Statistics

Estimation complete! Parameter change criterion (ETOL) reached.

Aquifer Model: Leaky
Solution Method: Hantush-Jacob

Estimated Parameters

Parameter	Estimate	Std. Error	Approx. C.I.	t-Ratio	
T	104.7	4.823	+/- 9.497	21.71	ft^2/day
S	1.048E-5	5.525E-6	+/- 1.088E-5	1.896	
r/B	0.001028	0.0003321	+/- 0.000654	3.097	
Kz/Kr	1.	not estimated			
b	60.	not estimated			ft

C.I. is approximate 95% confidence interval for parameter
t-ratio = estimate/std. error
No estimation window

K = T/b = 1.745 ft/day (0.0006157 cm/sec)
Ss = S/b = 1.746E-7 1/ft
K'/b' = 1.73E-7 min^{-1}
K' = 0.0002492 ft/day

Parameter Correlations

	T	S	r/B
T	1.00	-1.00	-1.00
S	-1.00	1.00	1.00
r/B	-1.00	1.00	1.00

Residual Statistics

for weighted residuals

Sum of Squares .... 1.426 ft^2
Variance .... 0.005185 ft^2
Std. Deviation....... 0.07201 ft
Mean .... 6.226E-5 ft
No. of Residuals 278
No. of Estimates 3
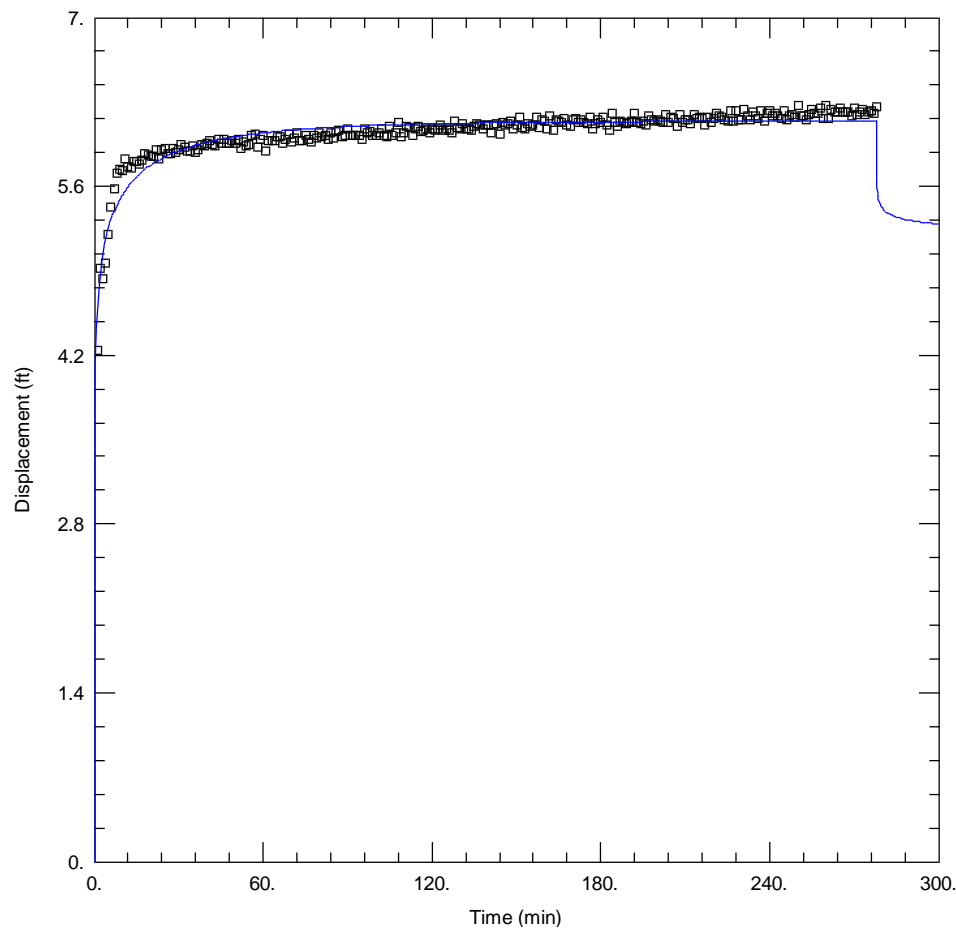
Obs. Wells
 □ Well 1 DrawdownOnly3gpm

Aquifer Model
 Leaky

Solution
 Hantush-Jacob

Parameters
 T = 104.7 ft^2/day
 S = 1.048E-5
 r/B = 0.001028
 Kz/Kr = 1.
 b = 60. ft

Project Pumping Well

Recovery Data only

Aquifer Model: Leaky
Solution Method: Hantush-Jacob

Estimated Parameters

Parameter	Estimate	Std. Error	Approx. C.I.	t-Ratio	
T	660.1	7.119E+4	+/- 1.397E+5	0.009273	ft^2/day
S	1.0E-5	0.01032	+/- 0.02026	0.0009686	
r/B	0.003956	2.393	+/- 4.694	0.001654	
Kz/Kr	1.	not estimated			
b	60.	not estimated			ft

C.I. is approximate 95% confidence interval for parameter
t-ratio = estimate/std. error
No estimation window

K = T/b = 11. ft/day (0.003881 cm/sec)
Ss = S/b = 1.667E-7 1/ft
K'/b' = 1.614E-5 min^{-1}
K' = 0.02325 ft/day

Parameter Correlations

	T	S	r/B
T	1.00	-1.00	-1.00
S	-1.00	1.00	1.00
r/B	-1.00	1.00	1.00

Residual Statistics

for weighted residuals

Sum of Squares .... 208.1 ft^2
Variance .... 0.143 ft^2
Std. Deviation....... 0.3781 ft
Mean .... 0.00138 ft
No. of Residuals 1458
No. of Estimates 3
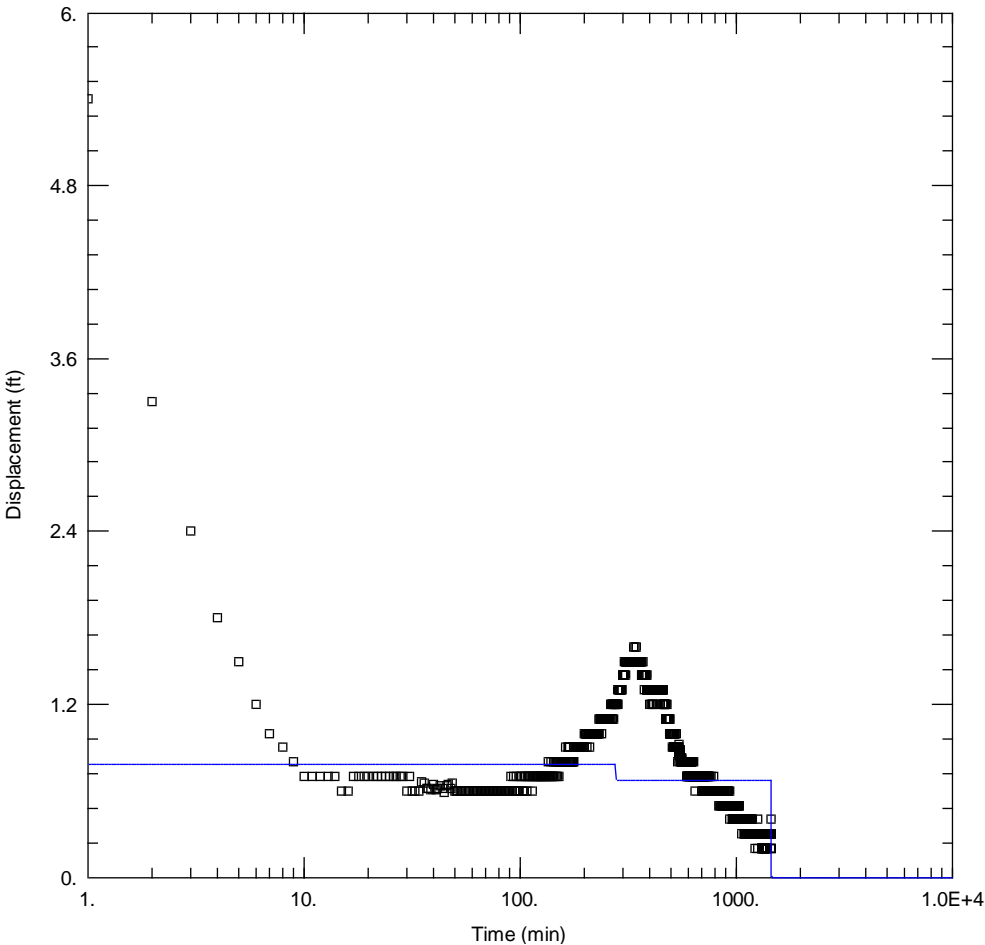
Obs. Wells
  □ Well 1Recovery

Aquifer Model
  Leaky

Solution
  Hantush-Jacob

Parameters
  T   = 660.1 ft^2/day
  S   = 1.0E-5
  r/B = 0.003956
  Kz/Kr = 1.
  b   = 60. ft

Diagnostic Statistics

Estimation complete! Parameter change criterion (ETOL) reached.

Aquifer Model: Confined
Solution Method: Theis (Recovery)

Estimated Parameters

Parameter	Estimate	Std. Error	Approx. C.I.	t-Ratio	
T	524.8	277.8	+/- 714.2	1.889	ft^2/day
S/S'	14.31	26.37	+/- 67.8	0.5427	

C.I. is approximate 95% confidence interval for parameter
t-ratio = estimate/std. error
No estimation window

K = T/b = 8.746 ft/day (0.003086 cm/sec)

Parameter Correlations

	T	S/S'
T	1.00	-0.98
S/S'	-0.98	1.00

Residual Statistics

for weighted residuals

Sum of Squares . . . . 0.02149 ft^2
Variance . . . . 0.004298 ft^2
Std. Deviation. . . . . . . 0.06556 ft
Mean . . . . -1.29E-10 ft
No. of Residuals 7
No. of Estimates 2

Obs. Wells
  □ Well 1Recovery

Aquifer Model
  Confined

Solution
  Theis (Recovery)

Parameters
  T   = 524.8 ft^2/day
  S/S' = 14.31
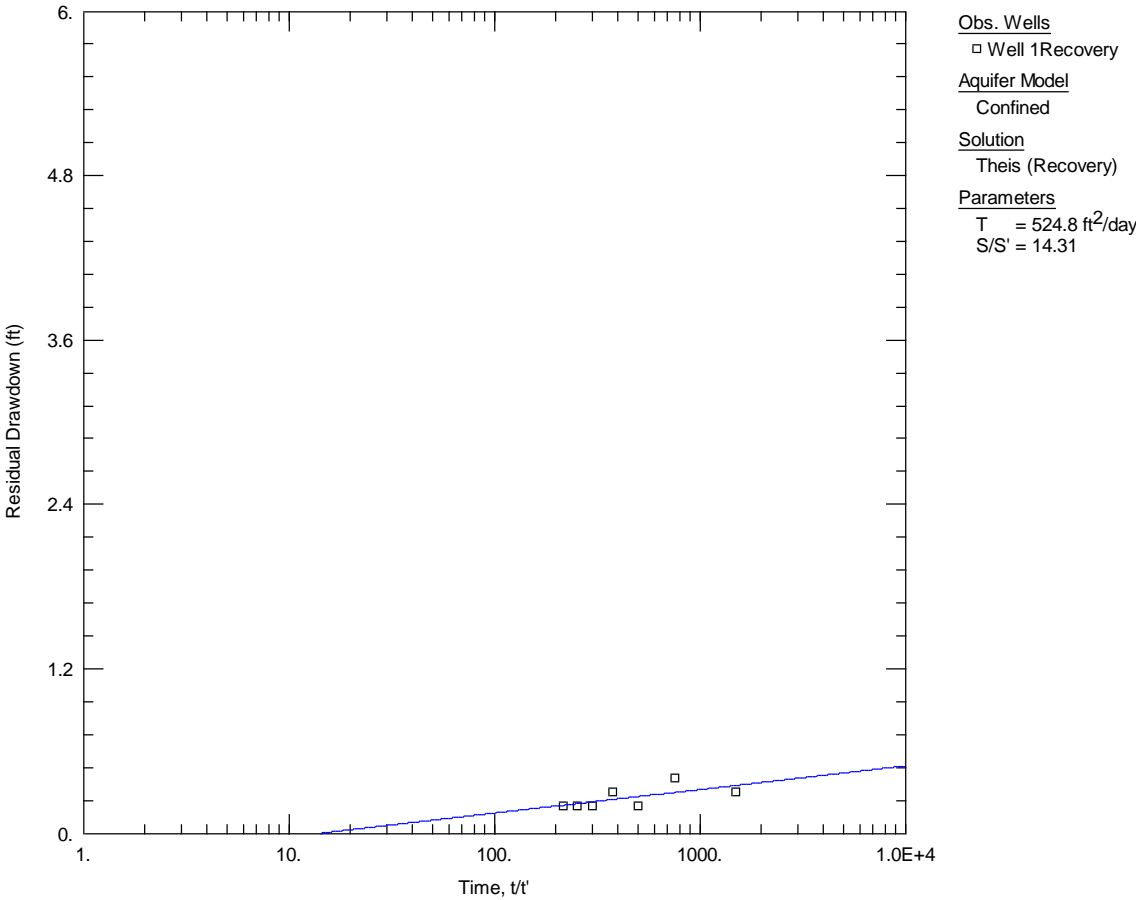
Diagnostic Statistics

Estimation failed to converge! Maximum iterations reached.

Aquifer Model: Fractured
Solution Method: Moench w/spherical blocks

Estimated Parameters

Parameter	Estimate	Std. Error	Approx. C.I.	t-Ratio	
K	19.02	5.081	+/- 9.968	3.743	ft/day
Ss	1.667E-7	0.004536	+/- 0.008899	3.675E-5	ft^{-1}
K'	1.44E-7	13.28	+/- 26.06	1.084E-8	ft/day
Ss'	1.0E-10	0.004513	+/- 0.008855	2.216E-8	ft^{-1}
Sw	0.	not estimated			
Sf	0.	not estimated			
r(w)	0.6667	not estimated			ft
r(c)	0.4167	not estimated			ft

C.I. is approximate 95% confidence interval for parameter
t-ratio = estimate/std. error
No estimation window

K = 0.006709 cm/sec
T = K*b = 1141.1 ft²/day (12.27 sq. cm/sec)

Parameter Correlations

	K	Ss	K'	Ss'
K	1.00	0.11	-0.11	-0.11
Ss	0.11	1.00	-1.00	-1.00
K'	-0.11	-1.00	1.00	1.00
Ss'	-0.11	-1.00	1.00	1.00

Residual Statistics

for weighted residuals

Sum of Squares .... 226.9 ft^2
Variance .... 0.1561 ft^2
Std. Deviation....... 0.3951 ft
Mean .... 0.01179 ft
No. of Residuals 1458
No. of Estimates 4
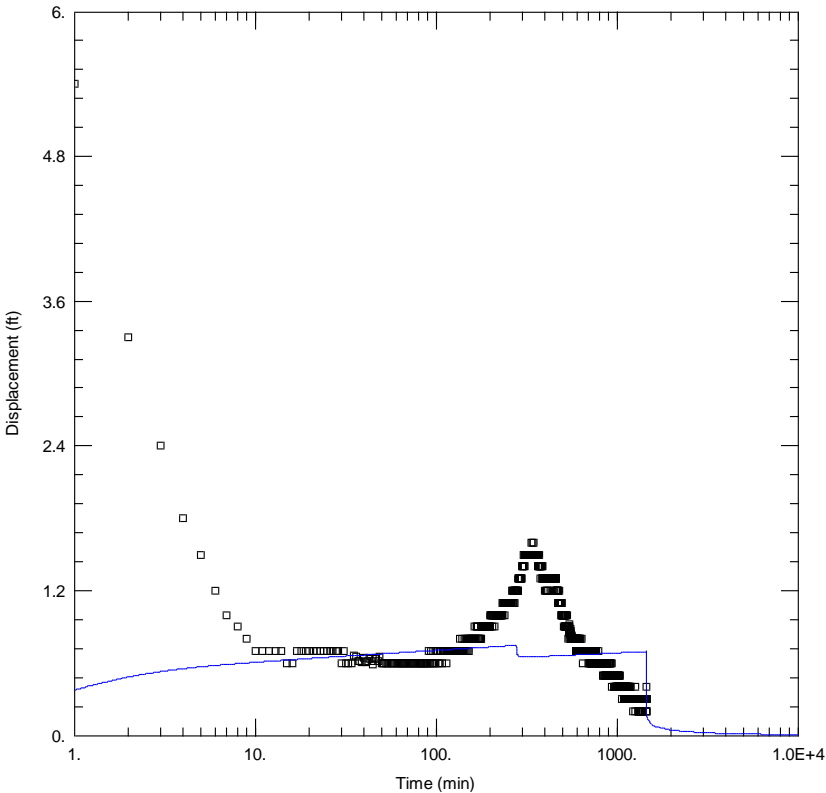
Obs. Wells
□ Well 1Recovery

Aquifer Model
Fractured

Solution
Moench w/spherical blocks

Parameters
K = 19.02 ft/day
Ss = 1.667E-7 ft^{-1}
K' = 1.44E-7 ft/day
Ss' = 1.0E-10 ft^{-1}
Sw = 0.
Sf = 0.
r(w) = 0.6667 ft
r(c) = 0.4167 ft

Diagnostic Statistics

Estimation complete! Parameter change criterion (ETOL) reached.

Aquifer Model: Fractured
Solution Method: Moench w/slab blocks

Estimated Parameters

Parameter	Estimate	Std. Error	Approx. C.I.	t-Ratio	
K	18.98	5.108	+/- 10.02	3.715	ft/day
Ss	1.667E-7	0.00142	+/- 0.002785	0.0001174	ft^{-1}
K'	1.44E-7	4.042	+/- 7.931	3.562E-8	ft/day
Ss'	1.0E-10	0.001412	+/- 0.002771	7.08E-8	ft^{-1}
Sw	0.	not estimated			
Sf	0.	not estimated			
r(w)	0.6667	not estimated			ft
r(c)	0.4167	not estimated			ft

C.I. is approximate 95% confidence interval for parameter
t-ratio = estimate/std. error
No estimation window

K = 0.006695 cm/sec
T = K*b = 1138.6 ft²/day (12.24 sq. cm/sec)

Parameter Correlations

	K	Ss	K'	Ss'
K	1.00	-0.17	0.17	0.17
Ss	-0.17	1.00	-1.00	-1.00
K'	0.17	-1.00	1.00	1.00
Ss'	0.17	-1.00	1.00	1.00

Residual Statistics

for weighted residuals

Sum of Squares .... 226.9 ft^2
Variance .... 0.1561 ft^2
Std. Deviation....... 0.3951 ft
Mean .... 0.0104 ft
No. of Residuals 1458
No. of Estimates 4
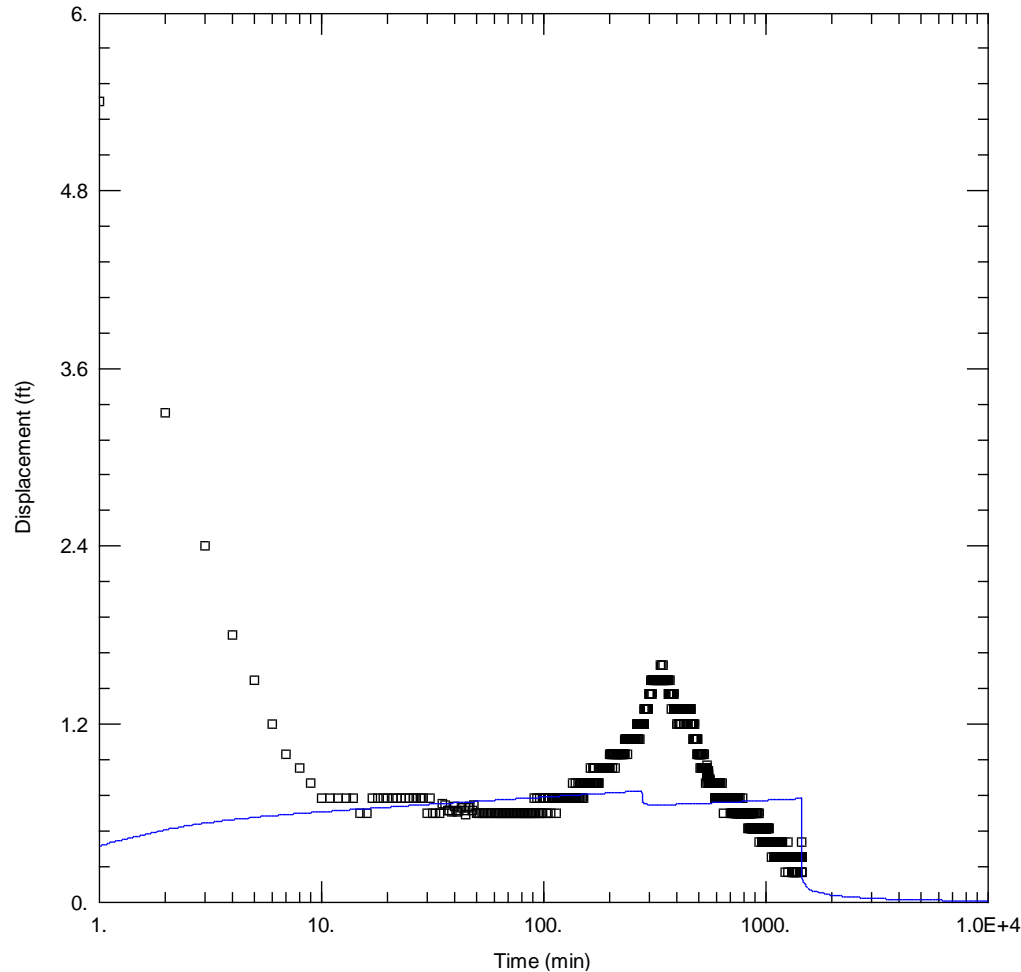
Obs. Wells
□ Well 1Recovery

Aquifer Model
Fractured

Solution
Moench w/slab blocks

Parameters
K   = 18.98 ft/day
Ss   = 1.667E-7 ft^{-1}
K'   = 1.44E-7 ft/day
Ss' = 1.0E-10 ft^{-1}
Sw = 0.
Sf   = 0.
r(w) = 0.6667 ft
r(c) = 0.4167 ft

Appendix B

Sonoma County Certification of Water Yield in Water Scarce Areas

COUNTY OF SONOMA
PERMIT AND RESOURCE MANAGEMENT DEPARTMENT
2550 Ventura Avenue, Santa Rosa, CA 95403-2829
(707) 565-1900   FAX (707) 565-1103

CERTIFICATION OF WATER YIELD IN WATER SCARCE AREAS
The Permit and Resource Management Department shall be notified 24 hours in advance of this test

Water Yield # WEL18-0545

Well Permit # WEL94-4483

I. Individual performing test: Michael Sherwood

II. Type of license/registration, number and expiration date: CA Professional Geologist #8839

III. Location of well:
Address: 2425 Pool Ridge Road, Guerneville   A.P. #: 069-160-027

IV. Type and model of test pump: 1 HP 230V Goulds 10 LS10 submersible

V. Test pump setting depth: 180 ft

VI. Maximum reported yield for this pump type at this setting: 9 gpm

VII. Type of discharge measurement method: In-line Flow Meter

VIII. Type and model of flow meter (or provide an accurate description of weir or orifice plate):

5/8' Badger in-line flow meter

Geographic coordinates (Plane Coordinate Method or distance from fixed landmarks): 38°30'59.21" N -123°1'13.21" W

IX. Estimated elevation of well head: 928 ft

X. Initial static water level (include measuring points such as top of casing, surface seal, access port): 166 ft from top of casing

Casing is 1.25' above ground surface

XI. Date & time of initial static water level measurement 10/24/18 7:07 (a.m)/p.m.

    A. Discharge Rate: 3 gpm/2.56 gpm
    B. Dynamic Water Level: 171.9 ft/171.5ft
    C. Specific Capacity: 0.46/0.43 gpm/ft
    D. Pump Test duration: 24 hours

XII. Immediately after the test take the following measurements:

    A. Dynamic water level: 171.28 ft
    B. Final discharge rate: 2.56 gpm

XIII. Post - Test Measurement:

    A. Dynamic water level: 171.28 ft
    B. Static water level: 165.97 after 24 hrs
    C. Percentage of recovery of final static level: 95.5%

Testing performed by (signature): _[signature]_

Date: 12/10/2018   Company: O'Connor Environmental Inc.   Phone Number: 707-431-2810

Approved_____ Denied_____   Specialist_____   Date_____

F:\WLS-010 Certification of Water Yield in Water Scarce Areas.wpd

Well Pump Test Data Recordation

Address: 2425 Pool Ridge Road APN 069-160-027

Date	Time	Interval	SWL	GPM	Comments		
10/24/2018	09:08	1 Min	169.96	3	Start pump at	9:07 AM	
10/24/2018	09:09	1 Min	169.64	3			
10/24/2018	09:10	1 Min	170.55	3			
10/24/2018	09:11	1 Min	170.68	3			
10/24/2018	09:12	1 Min	170.92	3			
10/24/2018	09:17	5 Mins	171.44	3			
10/24/2018	09:22	5 Mins	171.52	3			
10/24/2018	09:27	5 Mins	171.57	3			
10/24/2018	09:32	5 Mins	171.63	3			
10/24/2018	09:37	5 Mins	171.62	3			
10/24/2018	09:42	5 Mins	171.65	3			
10/24/2018	09:47	5 Mins	171.68	3			
10/24/2018	09:52	5 Mins	171.67	3			
10/24/2018	09:57	5 Mins	171.68	3			
10/24/2018	10:02	5 Mins	171.66	3			
10/24/2018	10:07	5 Mins	171.74	3			
10/24/2018	10:12	5 Mins	171.73	3			
10/24/2018	10:32	20 Mins	171.72	3			
10/24/2018	10:52	20 Mins	171.74	3			
10/24/2018	11:12	20 Mins	171.79	3			
10/24/2018	11:42	30 Mins	171.82	3			
10/24/2018	12:12	30 Mins	171.85	3			
10/24/2018	12:42	30 Mins	171.89	3			
10/24/2018	13:12	30 Mins	171.94	3			
10/24/2018	13:42	30 Mins	171.93	3			
10/24/2018	14:12	30 Mins	170.61	2.56	Drop Rate to	2.56	at 13:45 PM
10/24/2018	14:42	30 Mins	170.66	2.56			
10/24/2018	15:12	30 Mins	170.66	2.56			
10/24/2018	15:42	30 Mins	170.67	2.56			
10/24/2018	16:12	30 Mins	170.66	2.56			
10/24/2018	16:42	30 Mins	170.70	2.56			
10/24/2018	17:12	30 Mins	170.71	2.56			
10/24/2018	17:42	30 Mins	170.42	2.56			
10/24/2018	18:12	30 Mins	170.73	2.56			
10/24/2018	18:42	30 Mins	170.71	2.56			
10/24/2018	19:12	30 Mins	170.83	2.56			
10/24/2018	19:42	30 Mins	170.73	2.56			
10/24/2018	20:12	30 Mins	170.77	2.56			
10/24/2018	20:42	30 Mins	170.76	2.56			
10/24/2018	21:12	30 Mins	170.83	2.56			
10/24/2018	21:42	30 Mins	170.80	2.56			
10/24/2018	22:12	30 Mins	170.88	2.56			

Date	Time	Interval	SWL	GPM	Comments		
10/24/2018	22:42:00	30 Mins	170.87	2.56			
10/24/2018	23:12:00	30 Mins	170.89	2.56			
10/25/2018	23:42:00	30 Mins	170.90	2.56			
10/25/2018	0:12:00	30 Mins	170.91	2.56			
10/25/2018	0:42:00	30 Mins	170.99	2.56			
10/25/2018	1:12:00	30 Mins	170.98	2.56			
10/25/2018	1:42:00	30 Mins	170.96	2.56			
10/25/2018	2:12:00	30 Mins	170.93	2.56			
10/25/2018	2:42:00	30 Mins	170.97	2.56			
10/25/2018	3:12:00	30 Mins	170.94	2.56			
10/25/2018	3:42:00	30 Mins	170.99	2.56			
10/25/2018	4:12:00	30 Mins	171.01	2.56			
10/25/2018	4:42:00	30 Mins	171.03	2.56			
10/25/2018	5:12:00	30 Mins	171.03	2.56			
10/25/2018	5:42:00	30 Mins	171.01	2.56			
10/25/2018	6:12:00	30 Mins	171.11	2.56			
10/25/2018	6:42:00	30 Mins	171.13	2.56			
10/25/2018	7:12:00	30 Mins	171.13	2.56			
10/25/2018	7:42:00	30 Mins	171.20	2.56			
10/25/2018	8:12:00	30 Mins	171.21	2.56			
10/25/2018	8:42:00	30 Mins	171.25	2.56			
10/25/2018	9:12:00	30 Mins	171.30	2.56			
10/25/2018	9:19:00	7 Mins	171.28	0.00	Shut off pump	9:19 AM	
10/25/2018	9:30:00	11 Mins	166.42	0.00			
10/26/2018	9:36:00	24 hours	165.97	0.00			

Calculation of Well Recovery

(Worksheet example taken from PRMD No. 9-2-28)

1. Determine the water level draw down by subtracting the initial static water level measurement from the stabilized pumping level. Record this result as the well draw down.

2. Next determine the water level recovery by subtracting the post test (within 72 hours) static water level from the stabilized dynamic pumping level. Record this result as the well recovery.

3. Next determine the percent recovery of the well. Divide the water level recovery by the water level draw down and multiply by 100. Record this result as the percent well recovery.

Example:

a. Initial static water level: _____165.99_____ (measured value)

b. *Post test static water level: _____166.15_____ (measured value)

b.1. Time (hours) of measurement: _____24_____ (within 72 hours)

c. **Stabilized pumping level: _____171.28_____ (measured value)

d. Draw down: _____5.80_____ (calculate by subtracting A from C)

e. Recovery: _____5.31_____ (calculate by subtracting B from C)

f. Percent recovery: _____91.5%_____ (calculate by dividing E by D and multiplying result by 100)

Well percent recovery (F) must be 90% or greater within a 72 hour period.

* The static water level after 72 hours or less post pump test.

** Kleinfelder refers to this as the dynamic pumping level.